Smithsonian Institution

VOL. VI. JULY, 1882. No. 3.

THE KANSAS CITY REVIEW OF SCIENCE AND INDUSTRY.

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TABLE OF CONTENTS.

PAGE.

ANTHROPOLOGY.

1. Man's Zoogenetic Lineage.* H. A. Reid. 131
2. The Stone Age in Africa.* J. F. Snyder, M. D. 137
3. The Tablet of the Cross.* Warren Watson 142

METEOROLOGY.

1. Tornadoes: Their Special Characteristics and Dangers.* Sergt. John P. Finley . 144
2. Kansas Weather Service.* Prof. J. T. Lovewell 171

GEOLOGY.

1. Geological Notes on a Part of Southeast Kansas.* Prof. G. C. Broadhead . . . 172

PHILOSOPHY.

1. The Causes and Conditions of Knowledge.* R. J. M'Carty 175

CORRESPONDENCE.

1. Science Letter from Paris.* F. Connor. . 180

PAGE.

HISTORICAL NOTES.

1. Kansas in 1786.* J. R. Mead. 183
2. Treaties with Indian Tribes for Land in Missouri.* John P. Jones 184

BOOK NOTICES.*

1. Appleton's Annual Cyclopædia 189
2. Gateways to the Pole. K. P. Studley & Co. 189
3. Worms and Crustacea. Ginn, Heath & Co. 190
4. Wanderings in South America. MacMillan & Co. 190
5. Proceedings of the Academy of Natural Sciences of Philadelphia 190
6. Horses' Teeth. William H. Clarke. . . . 190
7. Other Publications Received 191

SCIENTIFIC MISCELLANY.

1. The Thunder-Bird.* Wm. H. R. Lykins. 192
2. Charles Darwin. John Fiske. 193
3. A Chemical Stove. 194
4. Deadening Sounds 194

EDITORIAL NOTES 195

*Written for the REVIEW.

Subscription Price, $2.50 per Annum, post-paid; Single Numbers, 25 Cents.

For Sale by the AMERICAN NEWS COMPANY, 39 and 41 Chambers Street, N. Y.

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REVIEW OF SCIENCE AND INDUSTRY,

A MONTHLY RECORD OF PROGRESS IN

SCIENCE, MECHANIC ARTS AND LITERATURE.

VOL. VI. JULY, 1882. NO. 3

ANTHROPOLOGY.

MAN'S ZOÖGENETIC LINEAGE.

BY H. A. REID, SEC'Y ACADEMY OF SCIENCES, DE MOINES, IOWA.

About twenty-five years ago appeared Nott and Gliddon's two great works, "Types of Mankind," and "Indigenous Races of the Earth," to which Prof. Agassiz was a contributor, and in which the doctrine that different types or races of men originated at different periods of geologic time and in different parts of the earth was ably and learnedly maintained. I once heard a bevy of clergymen at a Harvard Alumni dinner joking the great professor about his having taken their "father Adam" away from them. Next came Darwin's "Origin of Species," and about the same time Lyell's "Antiquity of Man." This was soon followed by Darwin's "Descent of Man," and Huxley's "Man's Place in Nature." And now within a few years Quatrefages' "Human Species"—Vol. XXVII Appleton's International Series)—Haeckel's "Evolution of Man," and Winchell's "Preadamites" have appeared; besides Prof. Whitney's recently restated and reinforced proofs that man existed in our Pacific Coast region as low down in the geological scale as the Tertiary age. (See Geological Chart in the REVIEW, Vol. V, No. 3, July, 1881.)

Prof. Haeckel's work on "The Evolution of Man," strikes the deepest of anything yet brought out on the subject, and bids fair in its essential principles

to eventually sweep the field. I will therefore trace the zoögenetic lineage of man after Haeckel's schedule, as concisely as possible.

The studies and researches in the science of embryology for more than two hundred years past, by De Graaf (1672), Leuwenhock (Spermatazoa, 1674), Purkinge, Von Baer, Agassiz, and many others, had wrought out the fact or general law that the embryo of each species of animals passes through stages and forms of structure simulating successively the typical forms that are below it in the scale of animal progress; and Man is no exception to the rule. Haeckel verifies this general law, but brings out some new and important points or theories with regard to this law of ontogenesis in general, and to the case of Man in particular. He traces the line of genetic succession, or the "connecting links," systematically down through all the geological ages, to the uttermost primordial inception of organic matter in the lurid and steaming muddy ooze of the pristine seas.

Scientists are now fairly agreed that protoplasm is the primordial form or condition of all organic matter, whether animal or vegetable; and Haeckel uses the term *moner*, to designate the ultimate particles of organic matter, as distinguished from *atom* the ultimate particle of inorganic matter. Eight genera of *moners* are now known and classified—and of course others may yet be discovered. Some of them are animal moners, some vegetable, and some neutral. A moner, then, is the last term, the absolute lowest, the very uttermost primordial form of organic matter. All embryos, all living creatures start here. So he calls the "Moner" stage of life *stage one* in the creational line which ultimates in Man—both as to the individual man born to-day, and as to the species Man in geological time. For the law of evolution, the law of heredity, and the law of embryology all converge into this one zoögenetic rule:—The growth-history and experiences of the individual of any species is in a general way the history and experience of the species to which that individual belongs.

From this first stage, or animal moner, comes the form of life called *Amœba*, which is merely an aggregation or community of animal moners. You will find the amœbæ described in any of our recent text-books on zoölogy; and they are generally regarded as the lowest form of animal life. It is a very minute or microscopic creature; and if you should look at it through a good microscope you would see at first what seemed to be only a bit of jelly, or slimy substance, of no certain form, and apparently inanimate. But presently at some part of its surface it begins to bulge, and it keeps on bulging until a rude sort of finger has been protruded. Perhaps it will touch some particle that may serve it as nourishment; then that bulged finger will bend a little and hug or clasp the nutrient particle to the body, and there it is dissolved, absorbed and assimilated into the substance of the creature, and the finger having, done its work, melts back into the general body again. The amœba has no mouth, no nose, no eye, ear, heart, stomach or bowels; no head or tail, no arms, legs or fins, it is simply a speck of animated jelly or slime-like mucos matter, sometimes called also *sarcode*, that improvises an arm or finger and a stomach at any part of its surface where occasion for it

happens to arise. It is for this reason also called *pseudopoda*—that is, false-footed, or not-to-be-depended-on footed.

There are many different species of amœbæ, and here the differentiation or divergence of specializing lines of animal structure already commences. And the next advance stage of animal life is the *Protozoa*, of which Professor Tenney, "Elements of Zoölogy," says: "The protozoans are probably more numerous than all other animals of the globe. * * * Rocky strata, hundreds of feet in thickness are wholly made up of their remains."

From the protozoan stage branched out many divergent forms, but the main trunk of the tree of life, according to Haeckel, kept on steadily toward Man. The third stage he calls *Synamœba*, or synthesized or compound amœba. The fourth stage is *Planœada*, a form of animal life corresponding to what is familiar to well-educated physicians as the blastosphere stage of embryonic development—a hollow sphere with walls composed of a single layer of cells. The fifth stage is *Gastrœada*, or the stomach-animal—a specialized digestive sac, with one opening to serve at once as mouth and ventrum. Its walls are composed of two cellular layers instead of one; and it is laid down as an established law of embryology that in all animal embryos at this stage, it is from the outer layer or exoderm that are developed the outer skin, hair, nails, feathers, scales, horns, hoofs, and all the organs of locomotion and external sensation; but from the inner layer, or entoderm, are developed the inner lining of the entire cavity of the body, also the glands and organs of nutrition, and the lungs, liver, heart, etc. Haeckel holds that as low down in the geological scale as the Laurentian period (see Geological Chart as above referred to) this form of animal must have existed quite extensively, as a free inhabitant of the yet simmering seas; but it had no hard parts of bone or shell or strong incasement, and therefore left no relic of its form or locality. The nearest living representatives of this hypothetical Gastræada are the larval forms of what are called in zoölogy ascidians or tunicata—a class of animals composed simply of a tunic or sac. They are sometimes called salps, or salpidæ, and you will find them described and figured in any recent good text book of zoölogy.

The next or sixth stage is called *Archelminthes*, or the primordial worm. The sac has become annulated or ring like, and has developed an intermediate layer of cells between the outer and inner layers of the gastrula stage. This vermiform stage is found in all higher animal embryos, and is represented by the zoölogical order of worms called *Turbellaria*. The seventh stage is a very slight modification of the last, and is called *Scolecida*, which is a general term for a large class of worms, some of them, like the *Turbellaria* themselves, being composed of only one joint or ring, and others of more; and here the pigment spots or rudimentary eyes are first detected. From the *Scolecida* stage of paleozoic life, as Haeckel thinks, branched off the line that developed the *articulata*—that is, all jointed animals, like crabs, lobsters, spiders, scorpions, bugs, ants, and insects of every sort; and also the line that developed the whole vast realm of molluscan life. But the main trunk of the tree of life

pushed on upward toward Man. And the eighth stage Haeckel calls the *Chordonium*—that is, when in the developing embryo (human) the first faint inklings of a dorsal chord begin to appear. This stage is represented in modern zoölogy by animals called *Appendicularia*, which are in appearance precisely like the embryo at this stage.

The ninth stage is called *Acrania*, or headless animal, and is the primordial vertebrate—the backbone, though merely rudimentary, being now distinctly indicated. This stage is represented by the animal called lancelet or *Amphioxus*, which Haeckel, himself, first demonstrated to be a true vertebrate and the transitional form or connecting link between the worm class and the vertebrate class. He thinks, at one period in the world's history animals of this type predominated and were the highest forms yet brought forth; but because of their having no hard parts their remains are not found in the rocks.

The tenth stage is the *Monorhina*, meaning that the mouth and nostrils are one—the nearest rudimentary development toward a specialized head; and this stage is now represented by the lamprey eel and the hag-fish or Myxine. The eleventh stage is *Amphirhina*, or mouth and nostrils differentiated. This stage is represented by the Selachian group of fishes, the remains of which are found certainly as low down as the Upper Silurian rocks, and they are the primordial type of fishes. These fishes had only a cartilaginous skeleton and not a true vertebral column or backbone; but their brain and nervous system, as also the heart and the organs of the senses were more highly developed than in the true bony fishes even of the present time; and their embryos showed a decided approach toward the amphibians. The modern rays, sharks, and some others, belong to this class of fishes. At this stage in the zoö-geological scale, according to Haeckel, the line of the bony fishes branched off, while the upward line developed into the twelfth stage, called *Dipneusta*—that is, double-breathers (having gills and lungs both), a type which is now represented by the animal called Lepidosiren. Prof. Nicholson, whose "Manual of Zoölogy" is a standard text-book in Scotland, the United States and Canada, says of this animal: "It exhibits a distinct transition between the fishes and the amphibia," (p. 399.) And again: "It may justly be looked upon as a connecting link or transitional form between the two great divisions of the fishes and the amphibians," (p. 401).

The next or thirteenth stage is called *Sozobranchia*, which means that they retain their gills through life although they cease to use them. The modern *Proteus*, the *Siren*, and the Menobranchs represent this stage. The fourteenth is the *Sozura*—that is, retaining the tail through life, and which type is represented now by the Tritons and Salamanders. From this stage the Batrachian class branched off, as represented by the gigantic extinct labyrinthodonts and the modern toads, frogs and salamanders.

Fifteenth is the *Protamnion*—a supposed animal in which a fœtal membrane first began to be developed, instead of the spawning process of the amphibian and lower forms. This stage is located as probably in the Permian period of geology, which was a great revolutionary or transitional epoch, a sort of interspaced

tumultuous and convulsional epoch of geological phenomena, between what is called Paleozoic and Mesozoic time. Its fossils are few, and it is therefore, called a "lost record" period of Prof. LeConte and others. The precursors of the *Dinosauria* or great biped reptiles, belong to this period; and it is specially noteworthy that the *Cheirotherium*, or "hand-beast" is first found here, for this is the first appearance on the earth of any form of anatomical structure which became ultimately a distinctive characteristic of Man and his zoological congeners; and this fact is certainly favorable to the supposed line of Man's evolution which I am now tracing through. It is from this stage that Prof. Haeckel thinks branched off the whole race of true reptiles—or the progress from spawners to egg-layers, (like turtles, alligators, etc.) and from this latter class ultimately came the birds, as shown by the researches and discoveries of Huxley, Marsh, Cope, and others.

But the anthropogenetic line moved on into its sixteenth stage, the *Promammalia*, or primordial mammal type, which is now represented by a class of anomalous animals called monotremata, with a combination of bird, reptile and mammal features in their anatomical structure, and of which the *Ornithorhyncus* and *Echidna* are the only living examples. And from this class or type the line of progress passed into its seventeenth stage, or the *Marsupialia*, representing a still nearer approach toward the true mammal. It is interesting to note here that some of the Dinosaurs (biped reptiles) were marsupial in their maternal characteristics. From this stage branched off one form of placental structure and habit called *Indeciduata*, or the placenta not falling off, and this divergence ultimated in the cetacean, the edentate and the ungulate families; while another branch called *Zonoplacentalia* ultimated in the carnivorous class, such as wolves, hyænas and dogs, besides cats, tigers and lions, and the great family of pinnipeda or seals. But another line called *Deciduata*—that is, the placenta ripening and falling away at parturition—continued on toward Man.

The next stage, eighteenth, is called *Prosimiæ*, or primordial ape-like animal. It is most nearly represented now by the lemurs; and from this stage branched off lines leading to the rodents, the bats and the insectivorous mammals, all of which have a discoid attachment of the placenta and also the ripening and dropping away of the placenta, the same as in Man.

The nineteenth stage is *Brachytarsi*, or short-footed; the *Macrotarsi* or long-footed type having branched off into the insectivora, like ant-eaters, armadillos, etc. The twentieth stage is *Anthropoidii*, or the man-precursor type of anatomical structure and physiological function; and from this stage, and partly also from the one below it, branched off the line which ultimated in the true *Simiæ* or anthropoid apes—the gibbon, the orang, the chimpanzee, and the gorilla. Haeckel dissents from Darwin and Huxley's theory that man is *derived from* the apes. He shows physiological and embryological reasons why that cannot be the line of Man's evolution—but that the *Simiadæ* or ape type branched off, specialized, culminated in the modern great apes, and could develop no further; hence they are a closed type, and will remain at their present status until they become extinct, while the

human type is in the embryonic line and still goes on toward higher developments.

The twenty-first stage Haeckel calls *Alalus Erecti*, or speechless man, (*Pithecanthropus* is another name for the same stage). And the twenty-second stage is *Homo Sapiens*, or true Man in the zoölogical and anatomical sense—the "carnal man" of the Bible as distinguished from its "spiritual man."

Of course I have had to run hastily over this consecutive chain of the great typical stages of the ascent of life from the *moner* up to Man, and omit the ample details of fact and reason, and known laws of life which Prof. Haeckel gives at every step to show on what scientific and philosophical data he bases each point or stage in the ascending scale. Every human being born into the world has passed through these successive transformations in his own embryonic development from the *moner* or primordial ovulum and its conjunctive spermat zoa, up to the perfected physical form of man. This is a settled truth of embryology, familiar to every cultured physician or physiologist. And whether Prof. Haeckel's localization of the corresponding stages in zoölogical evolution and geological time be literally correct or not, it makes a most valuable working hypothesis, around which to gather new facts and discoveries and prove or disprove any particular point in the schedule.

Then, animal man (the "carnal man" of the Bible) had come into existence by this long line of creational stages and processes; and each real or supposed change from any one stage up to the next higher one was in no case a greater variance or transmutation, either mentally, functionally or structurally, than are known to occur within human observation. And, as Haeckel well shows, there were constantly branching off lines of brute-life, thus eliminating out of the man-preparing line those grosser elements which produce shells, scales, fins, and armor-plates—pachydermatous skins, horns, hoofs, tusks, hair, wool, feathers, beaks, claws, and the like. All these elements had been diverted, drawn off, eliminated, strained out into diverging streams of animal nature and structure, before a kind of being was produced by this refining process which was sufficiently fine in quality of texture, and sufficiently complete in its coaptiveness of functional capabilities both mental and physical, so that God could make it into his own image—could breathe into its nostrils the spirit of life and make it a living or self-conscious soul. It is an old theological doctrine that Man was potentially in the Creator's mind and purpose from the first; and this Haeckelian schedule shows in a rational and tenable way how all the long slow processes of zoölogical evolution and geological time steadily worked toward the one grand purpose—the creation of Man as a finite intelligent being, and therefore an image or likeness of the Infinite intelligent Being.

THE STONE AGE IN AFRICA.

BY J. F. SNYDER, M. D.

A time undoubtedly existed in the early history of many primitive peoples when the appliances man brought to his aid, in the struggle for life, were such only as he readily found at hand convenient in form to meet his necessities, as sticks, shells and stones; and that in course of time experience suggested modifications of these natural objects, and he gradually learned to shape them, by breaking and grinding, into serviceable weapons and tools. When stone constituted the chief and best material for such implements that his ingenuity could discover, man is said to have lived in the "Stone Age." From wrought stones he learned the secret of reducing and combining in certain definite proportions the ores of copper and tin, making a compound, termed *bronze*, in many respects superior for his purposes to stone, and by its adoption attained the "Age of Bronze;" and, finally, in the discovery of iron, he began the "Iron Age" and his wonderful civilization.

The different eras of man's advancement indicated by these "Ages;" or, more properly, *stages*, of intellectual development, were not, as some are led to suppose, sharply defined measures of time during which the entire population of a continent or country simultaneously employed the use of stone, bronze or iron exclusively; but in each "Age" all substances previously found serviceable were of course retained in use; and a people in one locality may have known the art of utilizing metals at the same time another people occupying contiguous territory were ignorant of any better material than wood or stone.

These so-called "Ages," marking at the time the highest limit of a people's material culture, and not chronological periods, have come and passed in different parts of the world at different times, and now, at the present day, when the iron age is almost universal, tribes of degraded savages are known to be still destitute of all metals.

In considering the growth of mechanical ideas—constituting the basis and origin of civilization—this inquiry arises: have *all* primitive peoples, in emerging from the lower status of human life, passed through these grades of advancement in regular sequence, as pupils in our schools proceed from the elementary to the higher branches? Have wood and stone *invariably* constituted the alphabet and grammar, so to speak, of human skill in mechanism, necessary to be mastered before gaining knowledge of bronze and then of iron?

In reading reports of African explorations we are surprised to learn that some degraded savage tribes of the interior, who apparently had never before come in contact with civilization, were found to be supplied with not only beautifully wrought implements of wood and ivory, but also of iron produced from native ores and forged by native artisans. Their adroitness in smelting hematite

and working the metal is amazing. Another curious feature of that curious region arrests the attention; neither Livingston, Baker, Barth, Stanley, Speke, or other traveler, so far as my reading extends, ever mentions having seen there a wrought stone implement; and Dr. Livingston, in his last journal, remarks as a strange fact, that in all his wanderings in Africa he had never found or seen a stone artificially fashioned into a tool or weapon.

Travelers and other writers of first-class respectability have asserted that no stone age proper ever existed in Africa; some maintaining that its first inhabitants were exotics who carried with them from their starting place the knowledge of using iron, and others believing that the first negroes were autochthons who learned at once to smelt hematite, because they found that ore was the most abundant material and easiest of adaptation to their mechanical wants that their country produced.

In the course of certain investigations, relative to this subject, which for some time have engaged my attention, I addressed one of several notes of inquiry to Sir Samuel W. Baker, the renowned traveler and soldier, to which he promptly sent me the following courteous and characteristic answer:

SANDFORD ORLEIGH, Newton Abbott, Dec. 25, 1881.

My Dear Sir,—"In regard to your questions respecting a 'Stone Age' in Central Africa, I have never seen any stone that has been chiseled or worked in any manner of masonry. No vestiges of ancient masonry have ever been discovered among the purely negro tribes, nor do I believe that negroes, either in ancient days, or in their present savage state, were in the habit of shaping stones for dwellings. A stone age will only be represented in savage countries where stones suitable for cutting purposes exist. Flints, obsidian, quartz, but especially those which upon cleavage produce a cutting edge, are always adapted to the points and heads of weapons, should they be present upon the locality. But in some countries where such stones do not exist there never was (in my opinion) and never would be a 'Stone Age.'

"I have seen vast districts of alluvial soil in Africa where no stone, neither any metal could be found. In those localities there never was either a 'Stone' or an 'Iron Age,' but there was a 'Wooden Age' existing at the period of my experience, as their weapons were clubs, and spears, and arrows pointed with an exceedingly hard wood.

"Three or four hundred miles south of these districts the natives were good blacksmiths because hematite iron ore abounded upon the surface.

"These blacksmiths worked upon an anvil of a smooth block of hornblende and they used a hammer of the same stone.

"I never saw a stone weapon in Africa, neither did I see any other tools of stone except those I have described.

"There might be a 'Stone Age,' an 'Iron Age,' and a 'Wooden Age' existing at the same period within a few hundred miles of each other in any savage country where communication was difficult and the peculiar conditions of the va-

rious localities supplied a particular material in the absence all others; but I do not think a vestige of the so-called 'Stone Age' has been found in Central Africa.

"Trusting that this short opinion may be sufficient in reply to your note, I am Truly yours, etc.,

SAMUEL W. BAKER."

There has certainly *so far* been discovered not the least trace of a stone age in the interior of Africa; yet, no one has gone there purposely to look for it. While the observations and opinions of Sir Samuel W. Baker, (in many respects one of the most remarkable of living men), must be accepted as the highest authority in matters pertaining to his sphere of labors, it must be borne in mind that neither he, or any other intrepid men of education who have penetrated the depths of that strange continent, were especially devoted to the solution of its archæological or anthropological problems.

Vestiges of a stone age have been found in several parts of Africa bordering upon the coast; but so singularly limited in the number of objects discovered, when compared to the great profusion of lithic remains collected in the other continents, as to strengthen the impression that they may have been of extraneous and intrusive origin.

A few chipped flint weapons and neolithic polished celts from Algeria are in the museums of France, presumed to be relics of the Iberians, who crossed the Mediterranean about the close of the Pleistocene Age, and settling on the Barbary coast became the progenitors of the Berber and Moorish peoples.

A flint arrow-head is reported to have been found in Sierra Leone; and Mr. John Evans, F. R. S., F. S. A., mentions in his great work on "The Ancient Stone Implements of Great Britain," a celt, a hammer-stone, pestles, and some other articles of stone, in the Blackmore Museum, collected in the neighborhood of the Cape of Good Hope. The same author states that flint flakes are of frequent occurrence in the diamond diggings, and have been noticed in many different parts of the continent from the Cape to Tripoli.

In the African department of the Philadelphia Centennial Exhibition of 1876, were several palæolithic cutting implements of stone which the attendant in charge informed me were found not far from the coast in the vicinity of Port Beaufort. They were merely flat, irregularly round water-worn pebbles, of dark trap or hornblende, as large across as the palm of the hand, averaging three-fourths of an inch in thickness and ground down at one side to a sharp cutting edge. Neolithic stone implements have frequently been recovered from the old Egyptian tombs, and their manner of use is historical. Herodotus and Diodorus Siculus tell us that in the ancient rite of embalming, the body was always cut open with these sharp stone instruments, but the brain was extracted with a crook-iron. Recently, however, another class of stone implements have been found, deep below the surface of the ground, in the valley of the Nile, which Prof. Henry W. Haynes, who went to Cairo purposely to investigate them, after critical examination and comparisons, pronounces unquestionably palæolithic, of the

true St. Acheul class, and of course antedating by a vast lapse of time the earliest Egyptian civilization. From Herodotus we also learn that in the army of Xerxes, (B. C. 480), the arrows of some of the Ethiopian contingents were pointed with stone.

And this meagre record comprises almost the entire sum of our present knowledge concerning the employment of stone for implements on the African continent.

We can readily understand that primitive man, when completely isolated by natural barriers, could have learned to utilize only such materials as his habitat supplied; but on continents where his energies and movements were unrestrained by impassable limits, he must have been devoid of intelligence and capacity to progress if, in time, he did not become acquainted, either by migration, or barter, or reprisals in war, with the best substances attainable to serve his wants. Thus, the savages of the Pacific Islands, when first visited by Europeans, were dressed in garments made of the bark of their native trees, and armed with weapons made of wood and stones, and ornamented with sea shells indigenous to their shores. They could, unaided by visitors from other lands, never have done better; for their islands contained no metal-yielded minerals, or other materials than those they had learned to use. But in Europe and America the diverse peoples, restricted in freedom of range only by perpetual mutual enmities, learned the arts from one another and laid regions widely separated tribute to their needs.

The Indians of the Mississippi delta and Gulf coast, a vast tract of low alluvial country destitute of rock, were when first seen by the whites by no means in the simplicity of a wooden age, but were well supplied with implements of stone, including hornstone from Ohio, obsidian from New Mexico, and mica mirrors from North Carolina, and sported ornaments of copper from Isle Royale. During the stay of Cabeca de Vaca, for six years, upon the rockless shore of eastern Texas, he made several journeys far into the interior for supplies of flint for which he bartered the products of the coast; and the mounds of Wisconsin and Illinois, a thousand miles from the ocean, contain beads and drinking cups made of marine shells.

There is no reason to believe that the Indians of the Mississippi Valley, who built the mounds, and carved the hardest stones into pipes and images of admirable proportions and beauty, were in point of intelligence, mechanical skill, or in any other respect inferior to the iron-working savages of Central Africa; yet they dwelt for centuries upon and around the mountains of bare iron ore in southeastern Missouri and east Tennessee and elsewhere, surrounded with forests of fuel, without gaining a higher knowledge of the mineral than to use it as a common stone. They mined native copper with stone mawls and wooden shovels, by the aid of fire and water, and used the glittering metal only as a malleable rock. The outcrops of coal were their favorite haunts, but they never knew that the black diamond was combustible. They camped for generations on veins of galena without discovering that fire would melt it. With these minerals in the greatest abundance they had no better implements than those made of stone; and with deposits of ores the most readily fused and manipulated protending from the surface all around them,

profoundly ignorant of their properties, they journeyed hundreds of miles, braving the gravest dangers and hardships, to procure flint. As clubs and arrows they employed wood for weapons where flint and iron ore was as easy of access. The historians of De Soto's expedition recount the wounding of one of Mocoso's men, in western Arkansas, as the tattered cavalcade was returning from the plains to the great river, by an Indian in ambush, who sped an arrow that pierced the soldier's iron mail, passed through the muscles of the thigh, penetrated the saddle, and entered the horse's body, nailing the rider fast to his steed. On cutting and extracting the arrow they were astonished to find that it was merely a reed with the end hardened by fire.

After carefully sifting the glowing romances of Cortez and Bernal Diez, with the embellishments added by almost every historian in that field for the last three and a half centuries, it appears that the Pueblo Aztecs whose communal adobe houses were huddled together in the Mexican lagoon, were yet only in the stone age, possessing no better implements than those made of wood, flint and obsidian, and without knowledge of metals save ornaments of hammered copper and gold. The few objects of bronze; the unique and grotesque sculpturing, and splendid pottery of prehistoric Anahuac are the remains of a more advanced southern people conquered and displaced by the Pueblo horde that swept down upon them from the north, as the Vandals inundated Rome, destroying a culture which they had not the capacity to adopt or imitate.

Africa presents to the scientists many surprises, and among them possibly the amazing anomaly of a primitive savage people attaining at one bound the stage of development in mechanical arts gained by all other races of mankind, by slow degrees through ages of time and experience. The adoption of mechanical aids and appliances has been the outgrowth of man's necessities and environments, and the evolution of all his arts has been effected by gradual increments suggested by his increasing wants and expanding intellect. To this law Africa *may* present startling exceptions. As yet its interior is a *terra incognita* and its ethnography an unsolved enigma. Patient and careful research may in future be rewarded with some knowledge of the origin and migrations of its native races. Until exhaustive search for archaic remains has been instituted throughout its entire extent we are not warranted in assuming that any of its tribes, because of convenience of hematite, have suddenly sprung from Simian savagery to proficiency in blacksmithing. If after thorough search no traces of a stone age are found we must suppose that the aboriginal negroes had not advanced beyond the use of sticks and unwrought stones when the reduction of iron ore was introduced among them by Asiatic wanderers.

VIRGINIA, Cass Co., Ills., June 10, 1882.

THE TABLET OF THE CROSS.

BY WARREN WATSON.

An interesting and ingenious article appeared in the *Century Magazine* for December, 1881, on "The Hieroglyphics of Central America," a subject which has attracted the labors of many *savants* and the curiosity of the civilized World. Hitherto the inscriptions upon the mysterious ruins of Copan and Palenque have proved inscrutable; and the mossy records of a forgotten American civilization, preserved for posterity with such laborious care, are "sermons in stones" that none may read or expound. For a time it was supposed that a key had been discovered in the "*Relacion*" of Bishop Lauda, which contains what purports to be a Maya alphabet with an awkward explanation of the mode in which the letters were combined into words. But all efforts to decipher the inscriptions by its aid have thus far been fruitless.

In the article referred to, Mr. Edward S. Holden gives the result of his researches, in this field, with so much *eclat* that the reader is almost ready to admit his claim as discoverer of a clue to the difficult problem. This clue is the result of the study of a segment of hieroglyphs from the celebrated "Tablet of the Cross" at Palenque; and this being the fact a grave doubt arises as to the value of his discovery.

The "Tablet of the Cross," when *in situ*, occupied the south wall of the inner sanctuary of a small temple at Palenque. It consisted of a centre-piece, which contained the famous cross, on each side whereof was an inscription in hieroglyphics. The cross was embellished with the most bewildering arabesques and bore, perched on its top a grotesque bird; it rested on a hideous caricature of the human face. On the west side of the cross stood the figure of a priestess, perhaps, and on the east side a priest was making an offering to the bird. To the east of the priest were six perpendicular rows of hieroglyphics, there being seventeen in each row; and a similar inscription appeared to the west of the priestess. That the whole tablet, as thus described, is a genuine antique there is no sort of doubt; the difficulty lies in accepting the authenticity of the east inscription as given by Mr. Holden.

He states that "the cuts which accompany the present article are all copied from those given by Stephens, except the few which have been taken direct from Mr. Bancroft's "Native Races of the Pacific States" and from monographs for comparison. Turn to the cut given by Mr. Stephens of the Tablet of the Cross, (Cent. Am., Vol. II, p. 345,) and it will be found that only the centre and the west inscription are represented; and (on page 346) Mr. Stephens states: "The stone on the right (east) is broken, and unfortunately altogether destroyed." In Mr. Holden's cut the tablet is given entire with both inscriptions; that part, however, drawn by Mr. Catherwood, for Stephens' work, is reproduced exactly with

his signature, while, joined to this part in a clumsy fashion, the east inscription also appears bearing the signature "C. F. Trill." From this fact we are assured that Mr. Holden's cut is a piece of patchwork; and the assertion of Mr. Stephens' that at the time of his visit this inscription was "altogether destroyed" forces us to seek the source of Mr. Trills' drawing in the works of earlier explorers.

Calderon surveyed the ruins of Palenque in 1764, and was the first to make drawings of its antiquities; but his drawings were never published and are probably lost. In 1786 Del Rio made a very thorough exploration of the ruins. His report was published snd translated into English, and the translation contains a drawing of the Cross Tablet; but only the centre is given, both inscriptions being omitted. Dupaix was the next to explore and depict the ruins; and he had ample time (from 1805 to 1808) and the fullest means and opportunities to do his work thoroughly. His picture of the Tablet contains only the central stone with a row of eight fanciful hieroglyphs on each side. In 1831 Galindo described the ruins and made some sketches; but these have not been published and it is not known whether the Tablet of the Cross was among them. In 1832, Waldeck, who had engraved the plates for the English translation of Del Rio's report, visited the ruins and devoted two years to their examination. His drawings are the most careful, complete and beautiful that antiquarian zeal could produce, but the Tablet, as depicted by him, contains only the centre piece and the west inscription; that is it is precisely similar to Mr. Catherward's picture. Then came the visit of Stephens and Catherwood in 1840. Since that time M. Charnay has photographed the Tablet, but strangely enough, his plate contains the central stone alone. Other drawings are said to exist in various Spanish, Mexican, and Central American collections but none, other than those mentioned, have been given to the world in any publication accessible to students. The east inscription does not appear in the admirable compilation of Bancroft, in Shoot's "North Americans of Antiquity, or in any monagraph by original explorers that I have been able to find.

Now where did Mr. Holden get his authority to complete Mr. Catherwood's drawing by adding to it the east inscription? If the restoration of the Tablet, thus made, is authentic, he has performed a service of great value to American antiquarians (less favored with means of obtaining information) whether his exegetical speculations merit the claim he so enthusiastically makes for them or not; and it is hoped that the authenticity of his cut can be established. In the meantime, it seems a waste of leisure to attempt the interpretation of these baffling inscriptions, by means of a clue deduced from the stone so mysteriously recovered from the fragments found by Mr. Stephens, around the doors and corridors of the Temple of the Cross.

METEOROLOGY.

TORNADOES: THEIR SPECIAL CHARACTERISTICS AND DANGERS.

BY JOHN P. FINLEY, U. S. SIGNAL CORPS.

Having in a previous article touched upon the method of investigation, the importance and necessity of careful preparation and exact work, and portrayed at some considerable length the character and extent of the data required, I will now consider some of the practical results of such methods of labor. In other words I will, as far as present advance in this work will permit, answer the oft repeated questions on every hand: "What is the object of all this systematic labor under Government authority? How is it possible for the *people* to derive any benefit from that which appears to be conducted for the advantage of scientists only?"

In the first place we are starting out to discuss what? The cyclone? No. The tornado? Yes. Let us commence then by a use of the *right* name. Acquire the habit of calling things by their *right* names if you know them or have the means of information, and you will thereby avoid confusion of terms. Very likely you will save yourself many a fruitless search and not a few misemployed hours of study. The terms cyclone and tornado are constantly interchanged in their use and, in the minds of nine-tenths of the people who have occasion to use them, mean one and the same thing. This is not altogether surprising when we consider the meagre possessions of the most of mankind in regard to *accurate* meteorological knowledge and the general disposition of intelligent minds to speculate about the weather. There is, perhaps, no branch of science where a field for the roving and unsettled theorist is more opportune or more completely at his mercy. Discreet thinkers and careful observers everywhere, should grasp the importance of this situation and actively extend their sympathy and support in favor of mature considerations of well known principles. They should cheerfully assist in dredging the channels of human thought and clear away the feeling of mystery, even superstition, making common and useful one of the most important of all subjects, bearing upon the welfare of mankind.

Those atmospheric disturbances properly classed under the head of Wind Storms may be designated as follows: Cyclones, tornadoes, hurricanes, whirlwinds, waterspouts, hailstorms and thunderstorms.

CYCLONES.—A cyclone is not a tornado and it never can be. The two storms are essentially different. The former possesses the following characteristics: The path of the storm is a *parabolic curve*. It trends northwestward from the West Indies until it reaches parallel 30° N. when it curves to the NE. and continues in that direction, either at some distance off the Atlantic Coast, on its immediate border or a short distance inland. The storm finally disappears ocean-

ward in the vicinity of parallel 50° N. The diameter of the storm's path varies from several hundred to over one thousand miles. At the immediate centre of the storm there is a dead calm, a most fatal place for ships to be caught. At no point without the storm's centre does the air actually move or whirl in a circle, but there is a cyclonic tendency of the atmosphere about the region of barometric minima, viz: where the barometer is the lowest. Upon taking a number of points, located here and there in the four quadrants of the meteoric disturbance, it will be found that in the northeast quadrant the winds are from southeast to northeast; in the northwest quadrant, from northeast to northwest; in the southwest quadrant from northwest to southwest, and in the southeast quadrant, from southwest to southeast.

Again I repeat, a cyclonic *tendency* only. The barometer is a very important factor in all calculations bearing upon a determination of the character and approach of the cyclone at *any point* in the parabolic course of the storm. The wind very rarely reaches either an estimated or measured velocity of 100 miles per hour. The maximum velocity generally ranges from sixty to eighty miles per hour. As a rule there is no sudden, overwhelming dash of the wind, but a gradual approach or increase of movement which eventually culminates in a fierce intensity sufficiently powerful at times to destroy buildings or sink the largest ships. Cyclones occur most frequently in the months from August to November. In the China and Japan Seas this class of wind storms are called typhoons. In general, as to their place of origin, cyclones form south of the Tropic of Cancer, between the belt of calms and the southern limit of the trade winds; say briefly, in the vicinity of 10° N., 50° W. This region coincides with the zone of constant rainfall, where evaporation is very rapid, cloud formation exceedingly brisk, the air almost constantly saturated with moisture, and heavy condensation a regular feature of the day. Typhoons form south of the Tropic of Cancer and in the vicinity of the Philippine Islands, moving thence northwestward to the Asiatic Coast and then curving to the northeast over the adjacent seas and islands. As to the character of the region in which they form the same remarks apply as in the case of cyclones.

TORNADOES.—Comparing with the tornado which is truly and invariably a land storm, we find this peculiar atmospheric phenomenon possessed of the following prominent characteristics: A path varying in width from a few yards to eighty rods. The general direction of movement of the tornado cloud is invariably from a point in the southwest quadrant to a point in the northeast quadrant. The tornado cloud assumes the form of a funnel, the small end drawing near to or resting upon the earth. This cloud or the moving air of which it is the embodiment, revolves about a central, vertical axis, with inconceivable rapidity, and always in a direction contrary to the movement of the hands of a watch. The destructive violence of the storm is sometimes confined to the immediate path of the cloud, as when the small or tail end just touches the earth. While on the other hand as the body of the cloud lowers, more of it rests upon earth, the violence increases and the path widens to the extreme limit. The

tornado with hardly an exception occurs in the afternoon, just after the hottest part of the day and generally disappears before the going down of the sun. The hour of greatest frequency is between three and four P. M. A tornado very rarely, if ever, begins after six P. M. Understand me, a tornado *commencing* about five P. M. may *continue* its characteristic violence until nearly eight P. M. which only means that the tornado cloud may be *traveling* after six P. M. or after seven P. M., but it does not *develop*, that is, make its appearance, for the first time after those hours. Without the path of destruction, even to the shortest distances, at times even along the immediate edge, the smallest objects often remain undisturbed although a few yards distant the largest and strongest buildings are crushed to atoms. At any point along the storm's path, where there is opportunity afforded the tornado cloud to display its power, the disposition of the debris presents unmistakable signs of the revolving right to left action of the wind. The violence and intensity of the destructive power increases directly as you pass from the circumference of the storm to its centre.

Observations with the barometer are of little practical value at any one point, whether made before or after the tornado cloud has formed or while it is approaching. Such observations will not indicate its approach however near the position of the instrument to the point of the cloud's inception. The tornado season is embraced between the 1st of April and the 1st of September, although it can be considered unusual to record their appearance at any time in the former month. The months of greatest frequency are June and July. There are exceptional instances in a long series of years where tornadoes have been reported in every month of the year. They may, and sometimes do occur in some of the Southern States during the winter and spring months. Taking the whole United States together and averaging the dates of occurrence for a long series of years (nearly 90) it is found that the region of greatest frequency is the Lower Missouri Valley, embracing the States of Kansas, Nebraska, Missouri and Iowa. Of all the States in the Union, Kansas ranks the highest in regard to frequency.

HURRICANES —Although it seems hardly necessary to define the hurricane, it will perhaps be well to state that as here considered it means a straight wind of extraordinary velocity. They may and frequently do occur without the accompaniment of any precipitation. On the summit of Mount Washington, White Mountains, New Hampshire, a measured velocity of nearly two hundred miles per hour has been recorded. On the summit of Pike's Peak, Rocky Mountains, Colorado, a measured velocity has several times exceeded one hundred miles per hour. On the coast of the Carolinas maximum measured velocities have ranged from seventy-five to one hundred and sixty miles per hour. In the Eastern Rocky Mountain Slope and in the Lake Region measured velocities are sometimes recorded ranging between sixty and eighty miles per hour. This storm may be known as the Blizzard of the Northwest, the Chinook of the Northern Plateau, the Norther of the Southern Slope and Texas, or the Simoon of the Desert. Hurricanes may occur at any hour of the day or night and in any month of the

year. The most violent, however, take place during the spring and autumn. The width of the path of the storm is very irregular and may vary from many rods to many miles. In either case the velocity at all points within the storm's path is not necessarily the same; in fact such a conditon never occurs. The duration of the storm is also extremely variable, it may continue for only a few minutes or for several hours, although in the latter case the maximum velocity is not maintained throughout the entire period. On the contrary there are periods of recurrence alternating with decided diminutions of the highest activity. There are perhaps but few portions of the country altogether free from the possibility of their occurrence. In the low table lands of mountainous regions where most of the country is extremely broken, the habitable portions are shielded from the power of violent wind storms. No surface currents can attain any great velocity in such regions although on the mountain peaks and elevated plateaus dangerous hurricanes at times prevail.

WHIRLWINDS.—In defining these disturbances it will be best perhaps that you should be asked to recall the occurrence, on a warm, dry day, of the formation of a dust-whirl as it suddenly bursts upon you in the open street, fairly enveloping your body with fine particles of dirt, straw, leaves and the like. Whirlwinds suddenly start up from some barren, sandy spot unduly exposed to the direct rays of the sun. Over a small surface thus exposed the air rapidly rarifies and ascensional currents form which move spirally inward and upward, carrying dust, leaves, straws and sometimes objects of considerable weight. The air within the whirl moves either from left to right or in the contrary direction. The whirlwind's path has a diameter of several feet (sometimes rods) and the direction of its course of movement is decidedly irregular, possibly moving toward any point in the compass. On the sandy plains of Arizona, Southern California and Nevada these phenomena occur with great frequency during the summer months. Columns of whirling sand, sometimes several in a group, move rapidly over the surface. Whirlwinds are harmless and generally of but a few moments duration. In comparison with the tornado let it be born in mind that the former starts from the earth's surface, extends upward and moves onward, not leaving the earth, being solely confined to the region of surface currents. The tornado forms near the superior limit of the lower regions of the atmosphere and between the upper and lower sets of currents or the currents prevailing in the upper and lower regions of the atmosphere. The former currents are indicated by the appearance of the fine cirrus clouds and the latter by the heavy cumulous formations. From this lofty seat of origin the tornado cloud gradually descends to the earth's surface increasing rapidly in size and augmenting in power.

WATERSPOUTS.—These disturbances generally form at a considerable height in the air, although at times they seem to ascend from the water's surface; that is to say, there is no visible agent influencing the ascension of the water, but of course in every instance the causative power is from above and in the latter case near the water's surface. When I speak of the formation of the waterspout at a considerable height in the air, I mean that the embodiment of the whirl or the re-

volving current of air, first appears as a dark cloud of minutely divided particles of water, the result of rapid condensation, of course in the air and therefore above the water. The swift passage of the air in a spirally upward motion over the surface of the water raises it in the form of spray and carries it upward in the centre of the whirling cloud, which then presents the appearance of a densely opaque body and conveys an impression to the eye of the observer, that a huge column of water is ascending in the form of a long spout, widening gradually toward the top. There are instances, however, where the force manifested was sufficient to raise a considerable quantity of water several hundred feet in the air. Waterspouts form during periods of excessive heat, generally in the afternoon and at or near the hottest part of the day. In the temperate zone they only occur during summer months.

They are of most frequent occurrence in the region of calms between the Tropics, but are not altogether strange sights in the Gulf of Mexico and along the Gulf stream south of parallel 40° N. In regard to motions they possess both a rotary and progressive action, but in neither do they manifest a permanency of direction. Waterspouts cannot be considered as altogether harmless for there are instances where vessels have been wrecked by them.

HAILSTORMS—Are peculiar atmospheric disturbances which, in regard to the dimensions of their paths, are next to the tornado the most circumscribed of all storms save the whirlwind. They are characterized by a strange cloud formation and a peculiarity of precipitation unlike any other phenomena in the category of storms. The cloud from which the hail falls is basket-shaped with a dark and portentous exterior, a ragged and ominous looking opening at the bottom, and within, a whirling conglomeration of snow-flakes, pellets of snow and ice, partly formed and perfect hailstones, the latter of an almost infinite variety of shapes. The hail cloud forms between the currents of the upper and lower regions of the atmosphere and moves forward in the plane of these currents, either within or just above the upper limit of the lower atmospheric regions, where it finally disappears and the deposition of hail ceases. The path of the storm as indicated by the distribution of the hailstones is at times very narrow, although the range of width is decidedly inconstant, varying from one to fifteen miles. The hailstorm travels quite rapidly, from thirty to fifty miles per hour, and the length of its path is even more variable than the diameter, ranging as it does from ten miles to two or more hundred. The direction of the course pursued by the storm is always from some point west to some point east. It may be from northwest to southeast or from southwest to northeast. Hailstorms may occur at any time of the day or night, although they are most frequent in the afternoon, just after or near the hottest part of the day.

They are most prevalent in that region of country embraced between the parallels of 30° and 50° N. South of parallel 30° N. hailstorms are of rare occurrence at the level of the sea, but at the height of one or two hundred feet they occur more frequently, and in the mountains of British India they are very common, the hai stones being usually of large size. Hailstorms are not necessarily

confined to the land areas, but may and frequently do occur over large and small bodies of water.

THUNDER-STORMS.—These phenomena are atmospheric disturbances of great variability of extent and power. They are invariably accompanied by such manifestations of the presence of electricity as are ordinarily termed thunder and lightning, the former being entirely consequent upon the existence of the latter. Thunder is but the reverberations of the concussion produced by the inconceivably rapid propulsion through the air of that physical element we are pleased to term electricity. Thunder-storms may be a few miles or several hundred in extent, and their length of duration is quite as uncertain, viz: from a few hours to one or more days. There is no regular time of day for their occurrence, although they are perhaps more frequent in the afternoon. However, they may occur at any time during the day or night. As to the season of year, summer is the period of greatest prevalency. There is no month of the year entirely free from them. Whether the precipitation be rain or snow the presence of electricity has still been manifested in the usual form. With the former character of condensation of vapor, the evidence of electricity is most common, while with the latter it is the rare exception.

As regards geographical distribution, thunder-storms are most frequent between the equator and parallel 40° N. and from thence to parallel 70° N. the average frequency diminishes with considerable rapidity. In the vicinity of parallel 80° N. it is believed they never occur, although this in the main is mere supposition. There are certain portions of the United States where thunder-storms are unusually frequent as compared with other parts. They seldom occur in the Pacific Coast States, especially California, and are most frequent and violent in the Eastern Rocky Mountain Slope, the Lower Missouri Valley and in the Lake Region.

Having briefly outlined the characteristics of the various classes of storms we will now proceed to consider more in detail the most important (at least in certain respects) of all atmospheric disturbances. At this stage of our inquiry in regard to the character and classes of storms, I presume it will be admitted, that no two of the several storms defined, at least *appear* to be alike. There are, however, points of resemblance and in some, these features are stronger than in others. As each is studied more carefully, the essential points of difference will be more clearly contrasted. It is not within the province of this memoir to discuss at *length* the points of difference or harmony nor enter into an intricate analysis of meteorological phenomena and the multiform operations of atmospheric changes attending the origin, development and complete formation of these disturbances. On the contrary it is my desire to make this publication, in *general*, a brief but comprehensive *resumé* of the leading features of storms, as known at least in the United States, if not in North America, and in *particular*, to present rather a minute consideration of the peculiarities of tornadoes, with a view to place at the disposal of the *people most interested*, the *facts* and *practical* results of past and

present investigations of this most terrible and yet most wonderful and interesting of *storms*, the dreaded tornado.

THE TORNADO.

What is a tornado? In defining this storm it would seem almost a necessity to rehearse its long line of striking characteristics, but this in the common acceptation of the term would not strictly be a definition. At the sacrifice perhaps of clearness, but for the sake of brevity, we will state that the tornado is that form of atmospheric disturbance which takes the outward, visible fashion or figure of a funnel-shaped cloud, revolving about a vertical axis from right to left with an inconceivably rapid movement and an immensity of power almost beyond calculation.

CONDITIONS OF FORMATION.—These may be divided into classes. First, those within the reach of and which may be known or investigated by an isolated observer. Second, those conditions only to be witnessed and analyzed by the intelligent and practiced eye of the student of the Weather Map. To the single observer, located mayhap at his farm home, the work-shop or the store, there are important atmospheric conditions which he may carefully watch and study with profit, viz: the gradual setting in and prolonged movement of the air from the north and south points; the gradual but continued *fall* of the thermometer with a prevalence of the former currents, and a *rise* with the predominence of the latter. If the northerly currents are the prevailing air movements at your place of observation, the atmospheric disturbance is forming to the southward, but to the northward of your location, if the prevailing air currents are from the south. Carefully study cloud development, color as well as form, also manner and direction of approach. The approach of the cirrus cloud (perhaps at a height of six to eight miles) from the southwest is very significant and is the first evidence of the gradual, but certain advance of the upper southwest current which eventually plays so important a part in the development of the tornado cloud. Clouds are but the embodiment of air currents, yet they are full of meaning. A study of the upper currents of the atmosphere would be impossible without their manifestations and that too in a variety of forms. Dispense with cloud formation, the face of the sky would become a blank, and intelligent reas ning thereof a superhuman task

Wind direction, temperature and clouds are the proper subjects of observation and thought by the isolated observer. The barometer is of little if any importance in this line of inquiry. If you cannot compare your barometric observations with those taken at near or distant points and at the same moment of actual time, they are of no practical moment, even though your instrument is a standard one and your corrections for temperature and elevation carefully applied. The storm you are watching for (the tornado) is an extremely local affair, whereas the barometer indicates general changes, affecting a large extent of country. Your instrument, if a standard, does not lack the possession of a delicate sensitiveness requisite for all the purposes of its construction. But if it were placed in

the immediate track of the tornado cloud, it would not indicate its presence until the crash of the storm was upon the instrument, when of course it would be too late and at best rather injudicious, to weather the fury of the storm for the sake of noting the rise or fall of the mercury. Barometrical observations appear to advantage and are absolutely necessary to a successful consideration of the meteorological conditions of tornadoes from the standpoint of the Weather Map From this panoramic view of the situation a vast extent of country can be most carefully watched from hour to hour, for days, weeks or months. Atmospheric conditions on opposite sides of the probable course of the storm can be watched from their inception and any relation easily detected and analyzed. From a study of the Weather Map it has been found that the formation of what is termed a barometric trough or elongated area of low pressure (where the barometer stands below the normal for that region at the hour of observation) precedes the occurrence of tornadoes in the Lower Missouri Valley or adjoining States to the south and east. This low pressure area assumes the form of an elipse and generally extends from southwest to northeast between northern Texas and the Upper Lake Region. Such a depression may lie between the Central Mississippi Valley and the Lower Lake Region, trending northeastward just south of Michigan and over the Ohio Valley. The major axis of either of these depressions is easily estimated, while the minor axis may be stated as generally varying from three to five hundred miles. To the north of the major axis, even to a distance of several hundred miles, the winds are found to proceed from any or all points between northeast and northwest with comparatively low temperatures accompanied sometimes by a cold rain or even snow. South of the major axis and generally to a greater distance, the winds come from any or all points between southeast and southwest, accompanied by comparatively high temperatures, high humidity and often dashes of quite heavy rain.

As these conditions continue to prevail there is a growing contrast of temperature to the north and south of the major axis, owing to the long continued movement of the atmosphere from opposite directions, such movement eventually affecting the disposition of air in the warmer regions of the extreme south and likewise the colder regions of the extreme north. The contrast of temperature now naturally increases with marked rapidity and the formation of clouds commences in earnest. Huge masses of dark and portentous appearance bank up in the northwest and southwest with amazing rapidity and soon the scene becomes one of awful grandeur. The struggle for mastery in the opposing currents is thus indicated by the gathering cloud formations. The condensation of vapor from the extremely humid southerly currents by contact with the augmenting cold of their struggling opponents continues. It increases rapidly. Finally, when the tenacious hold upon a stable equilibrium can no longer be maintained (which is controlled by the rapidity and extent of condensation,) the opposing forces are, as it were, broken asunder, followed by the upward rush of huge volumes of air. The outward indication of this event is first shown in the whirling, dashing clouds over the broken surface of the heavy bank of condensed vapor, forming the back-

ground. A scene not easily depicted or realized by one who has not witnessed it, but never to be effaced from the memory of the actual observer. There is an awful terror in the majesty of the power here represented, and in the unnatural movement of the clouds, which affects animals as well as human beings. The next stage in the further development of this atmospheric disturbance is the gradual descent of the funnel-shaped cloud from a point apparently just beneath the position of the enactment of the first scene. The tornado is now before us, not fully developed, but soon to acquire that condition, when the terrible violence of its power will make the earth tremble, animals terrified, and men's hearts quake with fear.

PREMONITORY SIGNS.—On the day of the storm and for several hours previous to the appearance of the tornado cloud, what indications of its probable formation and approach are within the comprehension of any ordinary observer and can readily be detected by him? A sultry, oppressive condition of the atmosphere thus described by various observers as follows: "I really experienced a sickly sensation under the influence of the sun's rays." "I was compelled to stop work on account of the peculiar exhaustion experienced from physical exertion." "It seemed as if the lightest garments that I could put on were a burden to me." "There was not a breath of air stirring." "The air at times came in puffs as from a heated furnace." "I felt a want of breath, the air frequently appearing too rarified to breathe freely." "I was startled at the sudden and continued rise in the thermometer, especially at this season of the year." "In the forenoon I actually wore an overcoat, but shortly after dinner I put on my straw hat and worked in my shirt sleeves." "I noticed a remarkable change in the temperature, many of the neighbors spoke about it and said that there was peculiar feeling about the heat, something they had not before experienced in years." "It was terribly oppressive; it seemed as if the atmosphere was unusually heavy and pressing down on me with a great weight."

Enough examples have now been cited to clearly indicate the character of this peculiar sultriness. Other signs equally important and reliable may be found in the development and peculiar formation of the clouds in the western horizon. Sometimes these peculiar clouds extend from the southwest through the west by the north to the northeast. More frequently, however, they form in the northwest and southwest, sometimes commencing, first in the former quarter and then again in the latter, but in either case they are equally significant. The marked peculiarity of the clouds is found to occur not only in the *form* but in the *color* and *character* of development.

The sudden appearance of ominous clouds, first in the southwest and then almost immediately in the northwest or northeast (perhaps the reverse in the order of their appearance) generally attracts the attention of the most casual observer and frequently overcomes him with astonishment. In almost all cases these premonitory clouds are unlike any ordinary and usual formation. If they are light, their appearance resembles smoke issuing from a burning building or straw stack, rolling upward in fantastic shapes to great heights. Again, like

a fine mist or quite white like fog or steam. Some persons describe these light clouds as at times apparently irridescent or glowing as if from their irregular surfaces a pale, whitish light was cast.

The dark clouds at times present a deep greenish hue, which fairly forebodes the greatest evil and leaves one to imagine quite freely of dire possibilities. Again, they appear jet black from centre to circumference, or in a change of form, this deep set color may only appear at the centre, gradually diminishing in intensity as the outer edges of the cloud or bank of clouds are approached. Sometimes these dark clouds, instead of appearing in solid and heavy masses, roll up lightly, but still intensely black like the smoke from an engine or locomotive burning soft coal. They have been described as of a purple or bluish tinge, or at times possessed of a strange lividness. Frequently dark green, again an inky blackness that fairly startles you with its intensity. Many observers are at a loss for words in which to give an adequate description of the terrible scenes and simply say: "They were the worst looking clouds I ever saw, perfectly awful." Said one observer, "The clouds seemed to be boiling up like muddy water, the upper surface of the cloud reminding me of the incessant eddies or whirls seen in the muddiest portions of the Missouri River." Other observers as follows: "I saw two whirling circles of lightish gray clouds in the west; they were acting independent of each other and moved slowly inward toward each other from opposite directions. The clouds were very low; seemed to be on the earth, the wind in contrary directions across the face of the western sky and surrounding clouds in great confusion." "Observed clouds moving in all directions, some of a dark green color, others white as steam." "The lower end of the cloud was very white like fog." "I saw a great smoke, and supposed at first it was a fire." "I saw a terrible cloud of a dark purplish color." "There was a peculiar and terrifying look to the clouds." "I saw a green looking cloud in the northwest surrounded by others not so deep set in color. Under the cloud from the southwest, there came a large number of little thunder-heads, some very dark but others as white as steam. They seemed to be separated and running very low. I never saw clouds so low before. Pretty soon they began to go in all directions, some up, some down, right and left, backwards and forwards. I next saw a cloud that looked even all over in color and very white, the edges pretty even. It moved remarkably steady and seemed to be right under the edge of the cloud from the southwest." "The clouds looked as if a mosquito net had been spread out over the sky." "I saw clouds tumbling over and over in terrible confusion." "I noticed a strange action in the clouds and saw a cloud rolling on the ground coming from the southwest." "The ground was covered with white steamy looking clouds that prevented one from seeing any distance." "Two clouds, one from the northwest and the other from the southwest seemed to meet, and after meeting passed still lower. Above their place of meeting black smoke appeared in very peculiar shape." "The air presented a very peculiar appearance, it seemed to be in different shaded strata and quite marked." "At the bottom

of the cloud a hazy appearance rose up, obstructing the view." "Two clouds came together, one from the southwest and the other from the northwest; the latter was the highest, and the former the heaviest and looked the worst." "A heavy cloud spread out before us to a width of about six hundred feet, and as black as night."

The peculiar *action* of the clouds while they are forming is another interesting and significant feature which should be carefully watched. Under ordinary circumstances clouds form, move about and disappear without causing the slightest remark or perhaps thought, from the casual or even the interested observer. In the event of a thunder-storm or hailstorm the movement and disposition of the clouds are not looked upon with fear or as possibly possessed of a power to create great havoc. But on the occasion of a tornado the formation and movement of the clouds strike most persons almost dumb with fear. There seems to be some strange connection between the almost simultaneous appearance of clouds in the southwest and northwest, possessing as they do, such unusually threatening forms.

As they approach from opposite directions they are suddenly thrown into the greatest confusion, breaking up as it were, into small portions which dash pell mell over each other and in every direction, now darting toward the earth, now rushing upward to considerable heights like the ascension of a sky-rocket, or at moderate elevations rolling over each other in a well developed whirl. An observer in describing the approach of the clouds from the southwest and northwest stated that they "came together with a terrific crash as if thrown from the mouths of cannons." Generally, following closely upon the existence of this condition, the funnel-shaped tornado cloud appears against the western sky, moving boldly to the front from without this confused mass of flying clouds. As the tornado cloud advances these scuds continue to play about its top and sides, constituting a characteristic feature of the scene.

Another and invariable sign of the tornado's approach is a heavy roaring noise which augments in intensity as the tornado cloud advances. This roaring is compared to the passage of a heavily loaded freight train moving over a bridge or through a deep pass or tunnel. To the roaring of a railroad train such as is heard on damp mornings when the sound is very clear and loud. It is also likened to the rumbling of a long train of empty freight cars. The sound coming from the rapid movement of a large number of empty box cars is accounted rather peculiar and quite noticeable.

At times the roaring has been so violent that persons have compared it to the simultaneous "rush of 10,000 trains of cars." Of course there is no import ance to be attached to the exact *number* here given, it being used in a figurative sense and is quite likely exaggerated. Again, the roaring is likened to the low rumbling of distant thunder. The varying intensity of the roar as here represented is, in the main, due to the lack of uniformity in the positions of the various observers with respect to the advancing tornado cloud. Those situated nearest the cloud, other things being equal, experience the loudest roar, while to those

at greater distances the noise is proportionally weaker. In any event, however, the noise is sufficiently peculiar and distinct to create alarm and as a means of *warning* should not be overlooked under any pretext.

How to Benefit by Signs.—In order to be prepared for the possible appearance of a tornado, so far at least as the above indications are concerned, let every person situated in those regions of country where the tornado is of yearly occurrence commence (to-day is none too soon) to carefully observe and record the daily changes in the face of the sky, the variations of temperature, the direction of the wind and the character and development of clouds. I do not mean that any person should devote all or most of his time to this work of observation, and possibly not even all of his spare time. For the sake of regularity and uniformity I will suggest certain hours for regular work of this nature, viz: 7 A. M. 2 and 9 P. M. These hours are not altogether arbitrary, for there is a reasonable amount of prudence in their selection, looking to a proper and successful use of the results of your labor.

Should the violence of a storm be unusually marked during either the hours of the forenoon or afternoon, or even in the night, it would be advisable to increase the number of hours for observation and record, possibly making them every hour or half hour, or even at shorter intervals, as the importance of the case demands. By this means of frequent observation every feature of the storm would become the subject of inquiry and quite probably the most important results attained. For purposes of investigation of this class of storms your observations need not continue throughout the entire year, at least in the Northern and Western States, although such a length of record would by no means fall amiss of much value. Yearly records will pay. However, observations without fail, should commence by the 1st of April and continue unremittingly until at least the 1st of September. Observations through the autumn can be maintained with profit. It will be a valuable adjunct to this work of regular hour records if a summary of miscellaneous phenomena is kept. Enter the dates of occurrence and important particulars of such phenomena as auroras, mirage, meteors, lunar and solar halos, prairie and forest fires, the migration of birds and insects, the leafing and blossoming of trees, flowers and shrubs, droughts, excessive rainfalls, earthquakes, zodiacal light, frosts and the formation of ice. Blank record sheets, upon which such observations can be entered to advantage may be obtained free of cost on application to the Chief Signal Officer U. S. Army, Washington, D. C., provided, however, that a duplicate of each month's work, for which sufficient blanks and stamped envelopes will be forwarded, shall be mailed on or near the first day of each succeeding month, to the office of the Chief Signal Officer, U. S. Army. All such observers under the title of Voluntary Observers, Signal Service, U. S. A., in view of their labors in the interests of the Signal Service, will be entitled to and receive a copy of the Annual Report of the Chief Signal Officer, for that year within which they make the observations, and also a copy, (monthly) of another publication of the Signal Service called the "Monthly Weather Review," a most valuable journal of between twenty and thirty pages.

CHARACTER OF TORNADO CLOUD AND ATTENDING MOTIONS.—The tornado cloud is, generally speaking, funnel-shaped, that is to say, it tapers from the top downward, not always in the same degree with every appearance of the cloud, but the lower end of it (the part nearest the earth) is invariably the smallest. Whatever the inclination of the major axis of the cloud to the perpendicular, the lower end is the narrowest and nearest the earth. As seen in different positions and stages of development by various observers, located differently, the tornado cloud has been called: "balloon-shaped"; "basket-shaped"; "egg-shaped"; "trailing on the ground like the tail of an enormous kite"; of "bulbous form"; "like an elephant's trunk," etc., etc. In the majority of instances however, observers describe the cloud as appearing like an upright funnel. When the tip end of the cloud reaches the earth, the violence of its whirl creates a powerful suction over a small portion of the surface and immediately thereupon a peculiarly formed cloud of dust, and finely divided debris, around which there plays small gatherings of condensed vapor, is formed. To all appearances now, the tornado cloud has two heads, one on the surface of the earth and the other in the sky, the bodies of each joining in mid-air and tapering both ways with the smallest diameter at their junction. In other words, the cloud now assumes the shape of an hour-glass and the lower portion, or that assuming the form of an inverted funnel, displays an extraordinary violence. The extreme fury of the tremendous power of the tornado cloud is now experienced and nothing is able to stay the force of its awful march. This last and most fatal form of the tornado cloud is fortunately not a constant feature of the storm. The tornado cloud is constantly changing from the hour-glass form to that of the upright funnel or some other intermediate shape previously referred to.

The various gradations of form, not any of which however, affect the stereotyped relation between the size of top and bottom, number some twenty-five or thirty, so far as I have been able to gather information upon this point. These variations of form are quite important in a critical study of the tornado. They depend upon the peculiar movements of the whirling currents of air within and about the cloud vortex, the direction of the currents being outlined to the eye by the singular disposition of the rapidly condensing masses of vapor. The characteristic motions of the tornado cloud number four and are described as follows:

No. I. is called the *whirling* or *gyratory* motion of the tornado cloud, which is invariably from right to left or against the course of the sun. From the peculiar character of the formation of the tornado cloud, this motion is in all probability the first evidence of the existence of the cloud and should therefore be placed first in order of consideration. Of all other motions, this is attended with the greatest violence and its velocity of movement is far in excess of any one of the others. This gyratory motion forms what is termed the vortex of the tornado cloud, within which the velocity of the centripetal currents of air is almost beyond conception. Many efforts have been made, but most of them altogether fruitless, to estimate the rate of progress of these currents and velocities ranging from 100 to 800 and even 1,000 miles per hour, have been approximated. The two latter are the ex-

tremes that have been ventured upon and of course are not reliable, while in the majority of instances more trustworthy determinations have ranged between 100 and 500 miles per hour.

The uncertainty arising on this point of ascertaining the velocity of centripetal currents, depends upon or is rather an outcome of the difficulty attending the acquirement of the requisite (absolutely) reliable data. In all carefully conducted investigations heretofore made, there has unfortunately occurred such a long interval between the happening of the storm and the arrival of the person authorized to commence the work, that valuable and satisfactory results in this direction were precluded. It is always of prime importance to ascertain definitely, what portion of a building or other object was first struck by the wind in order to determine the configuration and inclination of the exposed surface. As a rule such examination is rendered next to impossible by the rapidity with which devastated districts recover from the violence of the storm. This statement is a most praiseworthy and well deserved commentary on the exemplary industry and determined spirit of the people of the Lower Missouri Valley. With the gyratory motion of the tornado cloud, objects are drawn inward to the centre of the storm and then carried violently upward by a spirally inward and upward motion which fairly crushes and grinds into pieces buildings, trees and whatever else falls in the line of the advancing cloud. The spirally upward motion throws the ascending debris in a circular manner, outward at the top of the tornado cloud. This debris when beyond the central whirl of the cloud, falls to the earth, but in such a manner and so disposed as to indicate the character of the force which acted upon it.

No. II. is called the *progressive* motion of the tornado cloud, the motion which determines the cloud's progress from one point to another. The rate of progressive velocity ranks next in order to the velocity of motion No. I. although it is certainly at all times far below the high degree of the latter.

The rate of progress of the tornado cloud is subject to great variability throughout the path of any one storm, although on the average tornado clouds possess a moderately uniform velocity of progression. Some observers have indicated the movement by the following expressions: "All in an instant." "Gone in a moment." "Quicker than thought." "Without a moment's warning." "It moved no faster than a horse gently galloping." "I just saw what it was, and then all was over." "Before I had time to turn about in my tracks it flashed by me." "It seemed to remain almost motionless, as if held to the ground by some mysterious force;" "I shuddered, held my breath, and the monster had vanished." "It seemed to move no faster than I could run."

These estimations of velocity are not to be taken altogether literally. The circumstances under which the impressions were received must be considered, viz: undue excitement or abject terror. However, the comparative results are important, and to a certain extent reliable. Through them, you will at least not be led astray in your conceptions of the awful grandeur of the panorama, or fall

into the fatal mistake of encouraging a belief that the tornado is not what the united experience of all observers has portrayed it.

This data will not answer however, to figure on very closely, but the factors, average diameter of cloud, actual time (local or standard) and measured distances, must be carefully obtained before an approach to accurate calculations can be secured. Reliable data are very difficult to obtain, especially time. This fact should be thoroughly appreciated by observers and every reasonable effort made by them to examine their clocks or watches upon the approach and passage of the tornado cloud. Generally speaking, it is a good habit to form, of jotting down in some place of ready reference the hour, day, month and year of notable events.

In regard to this matter of time, so far as past determinations can be valued, the progressive velocity of the tornado cloud is variously estimated at from twenty-five to seventy miles per hour. The former is perhaps too low and the latter quite likely too high, and although in both instances they represent the extremes, yet either of the above velocities may have existed for short intervals. The true average is probably about forty miles per hour.

No. III. is termed the *rising* and *falling* motion of the tornado cloud, the character of which finds definition in the following expressions from various witnesses: "The top of the cloud seemed to pop up and down, and then to rush forward." "It bounded over the ground like a ball." "It was the strangest jumping and flopping object I ever saw." "At times it seemed to lash the earth in terrific fury with its huge tail." "It came along, popping up and down in a most fantastic way." "Rising up like the uncoiling of a huge rope, it cut loose from the earth and passed over us with a horribly whizzing sound." "Ever and anon it would shoot directly upward from the earth, sometimes with great rapidity, and then again quite slowly, each time dashing to the surface with apparently renewed vigor."

It is perhaps clearly, seen that this a distinct motion with striking peculiarities which define its character. Sometimes, upon the lifting of the tornado cloud from the earth, it does not again descend for a distance of several miles, at times making the return movement or descension twenty or thirty miles distant, the intervening space proving a complete blank in its track. More frequently, however, these gaps are from one to five miles in length.

While the tornado cloud is traversing the atmosphere at some considerable distance above the earth, it may reach down so low as to just skim over the tops of the highest trees; descend to a level with the roofs of buildings, simply scaling off the shingles in spots or entirely on one side, leaving the roof-boards and rafters unmoved; removing the tops of chimneys; taking out all the fans in the wheel of a wind-mill and leaving every portion (even the tail) of the remainder of the mill unharmed; take off the cornice without disturbing the remainder of the roof; removing simply the top board of a five-board fence, or one or two of the top rails of an ordinary rail fence.

The tornado cloud may, however, remain at a perfectly safe distance throughout its aerial course and where it may be seen at a great height, moving solitary and alone, like a huge balloon. While in this condition it has, not a few times been unwittingly taken for the latter object, but the mystery and sensation was entirely dispelled when the news came in from the surrounding country of the frightful power of this now silent monster.

There is still another condition, which the fearful aeronaut may assume in his flighty movements. Upon rising from the earth and passing through a few uncertain struggles, apparently to decide as to whether the final direction shall be up or down, the tornado cloud is ultimately lost sight of in the surrounding clouds, and reappears suddenly again at its point of descension, or perhaps only to remain at a safe distance.

No. IV. is called the *zigzag* motion, or swaying from side to side of the central line of cloud movement. This motion is sometimes quite suddenly performed, but generally it is a moderately slow movement and one that can be attached and easily identified. It seems to occur most frequently just as the tornado cloud touches the earth in completing the last act of motion No. III. In completing the extent of a single act of this motion, the tornado cloud will diverge about an equal distance on either side of the central line of movement, though these tangents to the major axis are not necessarily of equal length.

At the commencement of this motion the tornado cloud, always moves first to the left (N. N. E.) and then to the right (E. S. E) forming an obtuse angle on the north side of the major axis. On the return movement, the cloud may or may not cross the major axis (to E. S. E.). If it does, it will then form a similar obtuse angle on the south side of the major axis. This zigzag movement, first from one side and then from the other of the central line of progressive action, may continue for several miles, or it may cut short its existence after the first few moves.

The regularity of this pecular action appears to depend upon indraughts from the south side of the major axis, of violent currents of air, which frequently advance (only from the left side) and give evidence of their existence by swaths or narrow paths of destruction (alternating with spaces of no damage) cut inward toward and joining with the central line or track. The tornado cloud may, upon the return movement, whether executed upon the north or south side of the major axis, it matters not, fail to cross it, but upon reaching it continue onward in the central line of movement to the northeast.

The distance traveled by the tornado cloud in departing from the major axis, either to the north or south, is generally subject to considerable variability, ranging from forty to fifty yards to nearly as many rods. While executing this zigzag motion it very frequently happens that the tornado cloud simply skims over the earth without manifesting its extreme violence.

BUILDING SPOTS.—In regard to the matter of buildings, the question may be asked whether there is not some choice in a building spot, with a view to safety from the violence of the tornado cloud. Many persons have thought that if their

house or barn was perched upon some high "divide" or on the brow of a steep decline, in fact upon any marked rise above the surrounding level, the tornado cloud by reason of some mysterious effort of clemency would rise from the earth and pass over them. This is a careless and unreasonable supposition when the facts are known. It does not seem to occur to the mind of an observer that there is no reason why the tornado cloud should not follow the rolling surface as well as the plain.

The tornado cloud pursues a general course to the northeast without regard to the character of the earth's surface and if your buildings are in the line of its destructive path, whether upon a hill, in a valley or within a ravine they are subject to its violence. Western towns as a rule are not built upon high "divides" but more frequently sheltered between neighboring hills. The same may be said of farm buildings, it being the prevailing custom to select building spots along the low bottoms of a stream for convenience to water and timber, and for protection from the continued heavy winds that break over the open prairies.

From the above facts it will be seen, that there is very little opportunity offered the tornado cloud to display its violence on the hill-tops, even though it were so diposed. Repeated investigations have shown that buildings were destroyed with as great violence and completeness upon high lands as upon low lands, but the largest number in valleys because of the facts above cited In many instances the funnel-cloud has passed from one ridge to another, doing damage on both, but skipping the intervening depression. Again it has followed high "divides" for several miles when they coincided with its general course of movement. Ridges and valleys are almost invariably crossed at right angles when their courses are from northwest to southeast.

ELECTRICITY—The rain and hail which sometimes precedes and at other times follows the tornado cloud, but always accompanies the heavy clouds which form in the north and west is not always but generally attended by lightning; sometimes most violent manifestations and then again but occasional flashes. The most terrific displays are reported during the heavy precipitation which often occurs after the tornado cloud has passed, some ten to twenty minutes. Very often its darting flash is observed in the dark clouds which begin to rise above the western horizon an hour or more before the storm.

What relation has electricity to the formation and power of the tornado cloud? Most persons are utterly at a loss to account for the terrible manifestations of the prodigious power presented to them by the destructive effects of the wonderful cloud formation. If they make the least attempt to philosophize upon the subject, they are determined to assign the cause to some mysterious interference of electrical force. Whenever a piece of iron is bent, broken, twisted or carried a considerable distance, a tree torn up by the roots, or clothing snatched from the body, it is attributed to electricity. The fact that it does not appear in the funnel-cloud is explained away by supposing that its subtle presence produces powerful effects through some incomprehensible modification of its usual character. There is a dogmatic predisposition to attribute everything, the result of un-

usual power in the operation of the tornado cloud, to this one member of the category of physical forces. Of course it is the easiest way to get rid in a difficult problem.

If a hurricane did similar work I dare say that the electrical (final and all-satisfying) cause would not be thought of. It being generally accepted that little is yet known of the peculiar nature of electricity, there would be comparative safety in assigning the cause of a strange atmospherical disturbance to its wonder-range of power, feeling satisfied, that for a considerable time at least, there would be no probability of a decided advance into the analysis of such a relation. The funnel-cloud is a mere collection of clouds of the same rarity as the mass from whence they are drawn. Its descent is evidently the mechanical effect of the whirling currents of air accompanied by the rapid condensation of vapor. Even if electricity is present there is no requirement of its intervention to produce the force required. It is plainly evident that the movement of a current of air at the rate of from 200 to 500 miles per hour is sufficiently powerful to demolish the strongest buildings, lift a piece of iron or if necessary distort its shape. This subject is considered more at length in my published Report of the Tornadoes of 1879.

MEANS OF PROTECTION.—First in regard to life. How can you save your lives or avoid the terrible injuries that often fail to result in death, but from which there is no respite while life hangs on? Much will be offered you in the solution of this vital problem from the results already permitted in a careful analysis of the facts now at hand. Perhaps it is more than you expect, perhaps it is less, but at least it is all that past or present investigation will sustain. In regard to this question much, if not everything, depends upon the manner and in what direction a person *moves*, together with the distance of the tornado cloud, its direction and the kind of *motion* prevailing at the *instant* you determine upon changing your position.

We will now suppose the various conditions and proceed to point out the necessary action in each instance. In all cases it is granted for sake of convenience in illustration, that you are in front of or situated directly in the line of the advancing tornado cloud. Under these circumstances if No. II or the *progressive* motion of the cloud is prevailing and your distance from it is say, eighty rods or more, *move* directly and with all possible dispatch to the *north*. Whenever this motion is prevailing *always* run to the *north*, unless in so doing you would be obliged to cross the *entire* path of the storm. A sharp glance to the *westward* will tell you whether you are about on the *southern* edge of the probable *path* of the tornado cloud, or more to the *north*. If in the *centre* or *halfway* between the *centre* and the *southern* edge, your chances are best in a direct course to the *north*. If further to the *south*, move directly and very rapidly to the *south*, bearing slightly *east*. In *no event* should you ever run directly to the *east* or *northeast*. Suppose the tornado cloud to be distant from you (W. or SW.) eighty rods and its progressive velocity sixty miles per hour, it would follow that one mile is passed in sixty seconds or eighty rods in fifteen seconds. Assuming the average width of the destructive path of the tornado cloud to be forty

rods and your position at the centre of that path, it will be seen that you have fifteen seconds in which to reach the outer edge of the path to the *north* (a distance of twenty rods) before the tornado cloud could arrive at your location.

I have taken an extreme case in every particular. Most persons first see the tornado cloud at a much greater distance, from one to three miles, sometimes five and ten miles on the prairies. Of course at the unusual distance of five or ten miles you could not determine very satisfactorily its probable course, especially with regard to your buildings or the safety of your own location. Watching the approach of the tornado cloud closely at a distance of ten miles and from that position on and on in its eastward course until it came within a mile or so of your point of observation, would give you sufficient opportunity to predict its probable course in regard to your location. When that matter is settled satisfactorily to your judgment, *move* immediately and without further hesitation. If you wait until the tornado cloud is distant one mile you have at least sixty seconds in which to run a distance of thirty rods, supposing that you are obliged to cover more than half of the destructive path of the storm. In an average case you will probably have between eighty and ninety seconds in which to run a distance of twenty rods. In either case I am supposing that you are prepared in every particular to *move* at the very *instant* of timely warning. Further, I am supposing that you have been watching the weather of the day and understand that a terrible storm is imminent. There is, under ordinary circumstances, no reason why you should not be so informed. A tornado cloud does not come out of a clear sky, and there are many and ample signs of its approach.

What has been said in regard to the *directions* in which persons should move when the progressive motion is prevailing, will for all practical purposes apply to motions Nos. I and III. With respect to motion No. IV, (the *zigzag*) the following preliminary remarks should be most carefully considered. Remember that while possessed of this motion the tornado cloud crosses from one side of the central line of movement or major axis to the other. That this peculiar motion most frequently occurs just after the termination of the *rising* and *falling* motion (No. III) so that when you see the tornado cloud descending to the earth from one of its aerial flights you may expect (not absolutely) the *zigzag* motion to follow. That the first departure of the tornado cloud from the major axis is to the left or on the *north* side of the path. That all departures from the major axis, whether *forward* or *return* movements of the tornado cloud are invariably executed to the *eastward*. There is no backward movement to the *west*. That the tornado cloud never continues to move in the direction of any *tangent* to the major axis but in the event of any departure it ultimately returns to the central line of movement. Having these points well in mind you are quite satisfactorily prepared to act when the exigency occurs. When the departure of the tornado cloud is to the *left* and your position is at any point in the central line of movement (better near the centre of the path) *move* directly *north* with the utmost rapidity, even if the cloud is at a long distance from you. Should it chançe that your distance from the cloud is reduced to from twenty to forty rods, run in-

stantly to the *south*, bearing slowly *west*. This movement will take you away from the forward and return action of the tornado cloud. Another case, suppose your position to be the same as just given, viz: at any point in the central line of movement, but that the tornado cloud had just crossed over that line to the *southward*. In this event you should move instantly and directly to the *north* bearing slowly *west*. This movement will also, as in the case previously cited, take you away from the forward and return action of the tornado cloud.

To recapitulate in regard to tornado cloud motions and the manner of movement with respect to them. Remember, that under no circumstances, should you move to the *northeast*, *east* or *southeast*. Never wait until the tornado cloud is almost upon you before you *move*. When watching the cloud in order to determine the course of its movement and decide upon the manner in which you will act in regard to its motions, place yourself directly in front of and as nearly as possible in a direct line with the advancing cloud. By thus selecting your position for observation you can determine more easily than in any other way the prevalence of characteristic motions, the change from one to the other and the most desirable *moment* in which to act in regard to any motion.

How to Act on Its Formation.—The following remarks apply to your manner of action when the evidences of the existence of the tornado cloud are undeniable. At this juncture the actual tornado cloud is not yet in sight but other infallible signs (heretofore given) of its formation and probable approach from a point possibly below your horizon, are present Act immediately, judiciously and with the utmost rapidity, but never for one instant allow yourself to become excited or reckless in anything. Take the situation as calmly as possible, knowing as you ought (or probably will) the terrible power you have to deal with. Do not with an over-weening sense of fancied security or an inclination to a superstitious feeling that your life is mysteriously over-shadowed by a peculiarly beneficent power, think and act leisurely about the matter of self-protection. A tornado cloud never sends forward a flag of truce or even solicits the "right of way." There are certain indications which we have heretofore spoken of that frequently, if not always, manifest themselves from half an hour to two or three hours in advance of the tornado cloud. Do not wait to make sure of the existence of the cloud or call into play a telescope to detect the charateristic outlines of the intruder and see if he corresponds with the regulation standard. It will pay you to run the chance of being trifled with, or disappointed if you so prefer to call it, several times rather than be compelled (when the opportunity to relieve yourself was once within your grasp) to weather a storm of this character. Of course you *may* get through alive, but then it is not such a change of scene and situation, so unusual and delightfully frisky in its nature, that you will needs pass through life with a stinging regret that you might have actually experienced this chief of "twisters." Even though you may feel an uncontrollable desire to serve the interests of science and those of the United States Weather Bureau, cast such ambitious and patriotic thoughts aside and prepare to flee, your back to the foe. Many foolhardy acts have been committed (perhaps through fear and

excitement or positive ignorance) by persons, which have resulted in death or dreadful injuries, because they tried to run in front of the tornado cloud, thinking they could outstrip it in such a race. Others have attempted to cross the path just ahead of the advancing cloud feeling that they could reach a safe distance on the opposite side before the funnel shaped monster passed. In one of our late storms a person essayed this trip with two horses and a lumber wagon, confident that he could at least rush his horses across the apparently narrow path of a storm which seemed to progress within such circumscribed limits. Not so. He was instantly killed, one of his horses dreadfully mangled, the other seriously injured and the wagon a total wreck. The work of an instant. An ignorant, reckless rush into eternity.

Had I the space I could enumerate many similar instances to show the folly and ignorance of people, and the importance of looking at this matter (the progress and power of the tornado cloud) as one of life and death. The second and last question arising under this heading (Means of Protection) pertains to the protection of property. What can be done to in any way lessen the actual damage (present or prospective) to property, especially buildings? In the first place it is utterly impossible to move your building or buildings from the path of the advancing tornado cloud. Secondly, it is positively impossible to stop the tornado cloud after it has started on its course of death and destruction or in any way prevent its formation. Thirdly, it is impossible to construct any building strong enough to completely resist the extraordinary violence of the tornado cloud. To sum up, this is all equivalent to saying that you can never expect to save your buildings. This is the truth as I comprehend it and it is that to which all thought upon the subject will sooner or later conform. It is advisible that, under all circumstances, you should avoid any labor *especially directed* to the construction of any building whatsoever, for the express purpose of resisting the violence of the tornado cloud. Build your houses, barns and stores as you would without the *knowledge* of a tornado. Other things being equal, a *frame* building is better than a *brick* or *stone* one. The former will hold together longer, is more elastic (if you will permit the term) and persons seeking refuge within its walls are much less liable to injury. There has at times been evidence to show, that of all frame buildings, those constructed with a hip-roof and a story and a half in height were the best able to resist the violence of the tornado. But where there are cases reported of this class of buildings being saved there are as many, if not more, where they were destroyed precisely as any other frame building would have been under similar circumstances.

It matters not how you construct or of what material, if your building rises above the surface of the earth (which it must necessarily do) it thereby offers obstruction to the advance of the tornado cloud and it will go, either from the foundation, or into kindling-wood and a distracted mass of bricks and mortar, in spite of the propagation of any theory or the possibilities of architectural skill. In conclusion I would finally say, that you must take every precaution to *avoid* or *remove* from, rather than attempt to *fight against* or in any way *resist* the power

of this formidable adversary. The question now suggests itself, what can be done? That which remains to be done can be accomplished in an unostentatious and quiet, but secure manner. Every man can and should construct a "dug-out" at some suitable point, within a convenient distance of his house. If a person is situated within a town or city let him select some portion of his yard for the purpose, but if residing in the country he will not be confined to narrow limits in the selection of a desirable location. Where a person living in the village has no yard, he must, if he has a cellar, construct a cellar-cave, to be described further on. With respect to the "dug-out," in no event should the roof be other than level with the surface of the earth, in fact it is highly desirable that the retreat should be so constructed that the ordinary surface of the earth would form the roof or covering and that all preparation of the domicile proceed by way of excavations and supports from beneath. As to location there is not much to be said, the most important points being convenient distance, a high, dry place, and possible opportunities to excavate into the northern or eastern slope of a knoll or hill. In the latter instance the entrance way would suffer less from the violence of the storm providing, perhaps, that it did not entirely envelop your retreat, for in that event, in the whirl of the flying debris, all sides alike would be at the mercy of the winds. Having decided upon the location, as regards your house or other buildings, prepare to sink a shaft, say four to six feet square, the entire depth of your "dug-out." From either the northern or eastern (better the former) wall of this shaft cut out a stairway leading upward to the surface of the earth, for purposes of ingress and egress. On the side of the shaft opposite the stairway commence the excavation for the enclosed retreat. The size of the room will of course depend upon how much you may at any time wish to secure from injury. Better have the excavation too large than not large enough. The slight difference in the expense of time and labor may, perhaps, be the means of saving you a great deal when you least expect it. The entire room should be below the surface of the ground, a distance of at least three feet and the overhanging roof of earth should be supported from beneath by heavy timbers, to provide against any emergency like the dashing of heavy debris upon it or the tramping of horses and cattle.

In the event of a tornado your retreat ("dug-out") may be entirely buried beneath huge piles of debris. Everything must be made as secure as possible. The entrance door should be made of the heaviest timbers and supported between casings of similar strength of construction. Arrangements should be made to secure the door by heavy fastenings. In order that ventilation may be provided for, a box spout, squaring eight inches, should be let through the roof. The top of this spout must be level with the surface of the ground and protected by iron gratings. Ventilation may be provided for by openings through the upper portion of the door, but these also should be protected by iron gratings.

The "dug-out" should be large enough to contain your family and remove thereto, such of your personal effects as are considered most valuable, viz: important papers, trunks of clothing, books, dishes, silverware, costly pieces of furniture,

anything of special value in this class of property. There are many instances where persons have lost the most valuable articles, even large sums of money, from supposing that if such things were placed in securely bound trunks or boxes they would be perfectly safe. There are cases where iron-bound trunks and even iron chests (not the regular merchant's safe) especially made to secure valuable articles, have been crushed or torn to pieces and the contents scattered to the winds. You might consider it advisable to purchase a heavy merchant's safe in which to lock your valuables. I would not advise you to the contrary, although it is a costly expenditure. It might resist the force of the wind to the extent that it would not be broken open, but if the tornado cloud possesses sufficient power (which it does)to remove loaded railroad cars from the track or overturn huge locomotives weighing tons, it will be seen that your safe will not very likely remain in its original position throughout the storm. Safes are not *safe* in a tornado. They may cost you several hundred dollars and even then you must prepare the "dug-out" for your family. Why not expend this money or that portion of it which is found necessary, in preparing not only a secure refuge for your family but sufficient room for your valuables? This "dug-out" need not prove a worthless investment even though you do not experience a tornado. On the principle alone that "an ounce of prevention is worth a pound of cure," the outlay cannot be considered a failure. It may be used for various purposes as an out-door cellar. If it prove the means of saving a life once in five years (and that, perhaps, your own) you would hardly regret the expenditure.

There is still another kind of underground protection which can be prepared to advantage if you are provided with a cellar, either under your house or store. Having the cellar, cut an opening (say six feet high and four feet wide) into the *wes* wall. Carry the excavation to such an extent underground as to provide sufficient room for your family and valuable personal effects. The roof of this cellar-cave should be composed of at least three feet (in depth) of the undisturbed surface earth, and supported from beneath by heavy timbers. In every way it should be made as secure as the "dug-out." The provisions for ventilation may be made through the roof or entrance door, but in either case well protected by iron grating.

PROTECTION IN CASES OF EMERGENCY.—In the event that you are not possessed of the dug-out or cellar-cave your best plan is to *move* from your house or wherever you may be at the *instant* stationed, as directed in regard to the various motions of the tornado cloud. If not able to benefit by these directions retreat instantly to your cellar and place yourself, face forward, against the *west* wall. This is the best position in any cellar. If, for any reason you cannot get to the *west* wall take your position (the next best) face forward against the *south* wall, but as near the *southwest* corner as possible. In these positions the building, if removed from the foundation, will always be carried above and over you, or if torn to pieces, the debris will be instantly removed to the eastward. *Under no circumstances, whether in a building or a cellar, ever take a position in a northeast room, in a northeast corner, in an east room or against an east wall.* Remember

that the tornado cloud invariably moves in a ***northeasterly direction.*** I have not space here in which to relate to you how many and in what manner persons have been instantly killed or terribly crippled, for no other reason than that they ignorantly threw themselves in the very grasp of the monster cloud. The lives of nineteen-twentieths, if not more, of the people destroyed in tornadoes can be saved by a clear understanding and a strict adherence to the simple rules herein set forth.

The rule regarding the movement to the ***northeast*** must be obeyed. The ***northeast*** quarter is a fatal position and I care not what you may tell me about destruction to life or property in any other. If you can get out of your house never remain in it or any other building that is at all likely to be torn down or removed from its foundation. If through some misfortune you are "close pressed" by the advancing cloud never remain ***standing*** and attempt to weather the storm, but throw yourself ***prone*** (face downward) upon the ground, head to the east and arms thrown over the head to protect it. If you should chance to be near a large stone or stump, or some heavy object low down and firmly imbedded in the ground, take a position directly to the east of it, lying prone upon the earth, head toward the object, protecting the former with your folded arms. This advice is given in the event of extreme exigencies where other and better opportunities have been forfeited. It is better, if possible, never to trust yourself behind or about any object located within the centre of the storm's path; by all means not a tree or any object that rises some distance above the surface of the ground. If forced to remain in your house and where you have no cellar, always take a position against the ***west*** or ***south*** wall (better the former) either prone (face downward) upon the floor or standing with your back to the wall.

In any building always take your final position on the first or ground floor. Never stand or lie in front of a door or window; near a stove or heavy piece of furniture. Make every effort to get into the ***west*** room and if possible before the onslaught remove therefrom all furniture, at least from the western portion. Always shut tightly every window and door in your house or other building in which you may be located at the time of the storm. You should never let doors and windows remain open during any violent storm. Never take refuge in a forest, in a small grove of trees, in an orchard, or near a fence of any kind, unless all these obstructions are entirely out of the line of the storm.

If possible always open your buildings and let your stock out, driving them to the ***north.*** In this matter of caring for stock (which should not be neglected if otherwise possible) always drive them from your buildings to the (as a rule) ***northward.*** Try and perform this duty on the first indications of the character of the storm, though not until you have assured yourself of the probable course of the tornado cloud. Of course it is quite possible that the tornado cloud may pass to the north of your buildings, in that event your stock should be driven ***southward,*** and ***vice versa.***

With regard to the protection of life and property in the many small towns, and even cities, liable to be visited by the devastating tornado cloud, what has

already been suggested in the manner of *north* and *south* movements, dug-outs and cellar-caves will, of course, apply here. Where, as in a village or city a large number of persons are congregated, each intent upon his particular business, it is hardly to be expected that perhaps any perso ı would find the time or think of giving any attention to the face of the sky. Should it chance that any person watched the changes of atmospheric phenomena and received indications of the approach of a tornado cloud he might not think it his duty (probably forget it in his excitement) to warn others of the impending danger, or provide for more than the safety of his own family.

Of course in any event it is natural to suppose that he would first secure his own household. This supposed case is a very probable one; at least nine times out of ten we find that towns are devastated without apparent warning and the unfortunate people startled from their imagined security, are killed in their struggling efforts for escape. Some provision should be made for the mass of inhabitants who are performing their various duties in and out of doors, and who by reason of their peculiar situation or labor could not, if they would, ascertain the prognostics of the sky.

With regard to this matter I will offer a few suggestions which may not be amiss. On any day when there is presaged in the weather conditions evidence of the probable approach of a violent wind storm, it should be the duty of those in authority to deputize certain intelligent persons, one or more in each ward, the number depending up the size of the town, to watch the character and approach of the storm, and if a tornado, to give timely warning of its advance to the various families in their respective wards, and take charge of the removal of persons and property to places of safety. In the matter of warning the various portions of the town, it would probably be to advantage to make use of the church and school bells by ringing them perhaps in a peculiar manner, the character of which to be decided upon by previous arrangement and generally understood. It should be generally known that the persons above referred to, give them what rank, title or emoluments you may, are possessed of special authority while performing their duties. They should be cool, brave, active and judicious men. They should completely understand the situation, know precisely what is needed and how to supply it. All pers ns should at the proper time appreciate the situation of these men and avoid confusion by a strict compliance with orders. I think that it will be clearly comprehended at this juncture, without resort to unnecessary recapitulation, that it will not be necessary for these persons so deputized by the proper authority, to be adepts in the science of meteorology or to take their posts of duty on the 1st of April and without removing their eyes from the heavens (except in the event of a tornado) gaze thereon until the 1st of September.

The signs (as before described) of tornado cloud formation and approach are distinct and sufficiently suggestive to afford opportunity for timely and concerted action. The time for action will necessarily be limited and the watch need not commence until there is every reason to believe that such a course is absolutely

necessary. Some persons may be disposed smile at the novelty and minuteness of this arrangement, or at the idea of employing weather guards at western towns. I will venture to say that these smiles will not appear on the faces of persons who have experienced the irresistible and overwhelming violence of a tornado. I have never detected many smiles among those who were left to tell the tale of distress in any of the many almost annihilated towns of the West. You may smile or wonder at the thought of hardy, brave men who have, without flinching and in support of their country's honor, faced the red-hot belchings of a score of batteries, who now at the sight of a threatening cloud or the experience of a brisk wind make a bold dash for places of safety or throwing themselves upon the ground clutch at the first object within reach. Such is the abject terror which possesses all alike after the experience of a tornado. The character and extent of your smile is but the measure of your blissful ignorance, and it should not be considered a misfortune to be compelled thus to remain without possession of the truth.

Immediately following (and for some weeks thereafter) the occurrence in Kansas and Missouri of the violent tornadoes of 1879 hundreds of people along the tracks and in the vicinity of the storms, hardly went to bed, but remained dressed and, with their lanterns trimmed and burning, watched intently every foreboding appearance of the sky. Every dark cloud or sudden increase of the wind was calculated to affect them with an indescribable terror which could not be allayed until every vestige of the supposed danger had vanished. This is not the pitiful tale alone of Kansas and Missouri sufferers, but wherever the dreaded tornado makes its way, be it in Michigan, in Mississippi, in Georgia, In Massachusetts or in Minnesota, the awful roar and power of its march strike all life dumb with fear. A great deal can be accomplished towards allaying this fear by a dissemination of practical knowledge concerning storms and by a general effort among intelligent people to appreciate such information. All intelligent persons can and should become familiar with the various classes of storms and be qualified to detect their formation and approach. The work of investigation is not yet finished. Much remains to be accomplished. We have yet a great desideratum probably within our reach, but not without careful preparation in the study of local and general atmospheric conditions. It is, that we shall be able to furnish timely and reliable warnings to certain communities, announcing conditions favorable to the formation of tornadoes. We shall then, with the knowledge now in our possession and in yours, be able to understand and act in regard to this wonderful storm in a manner quite satisfactory and little dreamed of a few years ago.

In a previous article (Tornado Studies for 1882) I have directed attention to the urgent necessity and the undeniable obligation resting upon every person who can, to furnish all the information within his power toward rendering the repeated investigations of tornadoes under the direction of the Chief Signal Officer, of the utmost value. The well organized State Weather Services of Kansas, Nebraska, Missouri and Iowa, under the efficient supervision of their several Directors, are doing most excellent general meteorological work. They should re-

ceive the hearty aid and appreciation of the people, and of the legislatures of their respective States. Every State should have a Weather Service, every township an observer and every chief observer at the county seat authorized to receive monthly reports from the various observers within his jurisdiction and forward the same monthly to the State Director of such Service. Each Director should have the time and force at his disposal to thoroughly digest the meteorological conditions of each and every month throughout the year, preparing and publishing at the termination of each twelve-month a general summary of atmospheric phenomena coupled with the evidence of earnest and well directed efforts toward comparative study and practical results.

Such funds as would be necessary to carry forward a work of this kind should yearly be appropriated by the State Legislature. As so organized and in working order each State Weather Service should coöperate with the United States Weather Service, at Washington, and thus complete a system of meteorological work without parallel in the nations of the World, which would effect a marvelous advance in the study of this most important science, and develop rapidly and with practical results the meterological conditions of this great country. I can here give but the merest outlines of a subject with regard to which I have given much thought.

There is no country on the face of the globe where meteorology can be studied with so much advantage practically and scientifically as in North America. The elementary principles of meteorology, especially in regard to storms, should be taught in every school, country, town and city. In the colleges and universities an advanced course should be prescribed. Speculation regarding the weather is exceedingy rife, affecting every branch of the science and in a manner quite without precedent in the line of methodical knowledge. In view of this fact and the scarcity and uncertainty of desirable text books, *facts* and *principles* should alone be considered in administering the prescribed course of any educational institution, from the lowest to the highest grade.

The American people as a rule are too much in haste for the solution of meteorological problems. They perhaps divine the benefits in store for them from those already received and cannot wait for a judicious presentation of them, but the law is in patience, possess ye your souls. Truth comes slowly but it is worth the waiting. I do not consider that in this short presentation of most important facts, I have altogether met the supreme desire, or perhaps, the hope of the people interested in the subject of tornadoes. Such desires or hopes may never be realized, at least not until the investigation and analysis of these phenomena have been perfected, yet you have before you in very brief form the results of over five years of labor and an examination of over 600 tornadoes.

I urgently request all persons who can give me any information on the subject of storms in general or of tornadoes in particular, to communicate with me at their earliest convenience. Specially prepared circulars, on what facts to furnish in tornado investigations, will be sent to any person whose address I can obtain.

REPORT FROM OBSERVATIONS TAKEN AT CENTRAL STATION, WASHBURN COLLEGE, TOPEKA, KANSAS.

BY PROF. J. T. LOVEWELL, DIRECTOR.

Highest barometer during month 29.52, on the 22nd. Lowest barometer during month 28.59, on the 17th.

Highest temperature during month 89°, on the 18th. Lowest temperature during month 37°, on the 26th.

The usual summary by decades is given below.

TEMPERATURE OF THE AIR.	May. 20th to June 1st.	June 1st to 10th.	June 10th to 20th.	Mean.
MIN. AND MAX. AVERAGES.				
Min	49.6	52.9	59.9	54.1
Max	66.7	75.6	81.0	74.4
Min. and Max	56.3	64.2	70.4	63.6
Range	20.7	22.6	20.9	21.1
TRI-DAILY OBSERVATIONS.				
7 a. m.	53.7	61.3	66.8	60.6
2 p. m.	63.1	74.2	79.1	72.1
9 p. m.	57.6	63.9	70.1	63.9
Mean	58.3	65.8	71.5	65.2
RELATIVE HUMIDITY.				
7. a. m.	.89	.81	.85	.85
2 p. m.	.75	.57	.66	.66
9 p. m.	.84	.73	.90	.82
Mean	.83	.69	.80	.77
PRESSURE AS OBSERVED.				
7 a. m.	28.97	28.95	28.87	28.93
2 p. m.	28.93	28.91	28.84	28 89
9 p. m.	28.94	28.91	28.85	28.90
Mean	28.95	28.92	28.85	28.91
MILES PER HOUR OF WIND.				
7 a. m.	13.3	8.7	. .	. .
2 p. m.	16.1	14.2	. .	. .
9 p. m.	8.5	12.4	. .	. .
Total miles	3334	. .	. .	. .
CLOUDING BY TENTHS.				
7 a. m.	6.7	3.9	6.1	5.6
2 p. m.	7.1	4.9	3.4	5.1
9 p. m.	6.5	1.9	4.2	4.2
RAIN.				
Inches	1.95	.98	2.90	5.83

GEOLOGY.

GEOLOGICAL NOTES ON A PART OF SOUTHEAST KANSAS.

BY PROF. G. C. BROADHEAD.

We find well exposed, below Iola at Humboldt in Allen County, about twenty feet of a whitish or light gray limestone, often cellular, with the cells ferruginous stained; it also often shows numerous facets of limpid calcspar. A similar rock occupies the bank of the Neosho River at Neosho Falls, also cropping out low in the hills at Chanute and is also found at Galesburg in Neosho County. At Galesburg we find a succession of strata, including a few feet of rough ash-gray limestone on hill-top, then twenty feet of calcareous shales and thin rough layers of limestone containing *Athyris, Subtilita, Productus splendens, P. prattenianus, Bryozoa, etc.* Below this we find beds of pure whitish and gray limestone, ferruginous tinged and containing *Bryozoa, Spiriferlineatus, etc.*, and with much crystallized calcite. This last limestone I regard as equivalent to the whitish limestone of Humboldt, and from its associated beds I would, in the absence of better evidence to the contrary, refer it to the age of a similar limestone very well exposed on the hill tops a few miles south of Ft. Scott and named by Prof. Swallow in his Geological Section of Southeastern Kansas, as the "Pawnee Limestone." We would also recommend a comparison of this limestone with another known limestone of Bates County, Missouri, occurring there less than twenty feet below the Mulberry coal, and described in Mo. Geol. Rep. 1874.

The occurrence of this limestone at Iola, Humboldt, Chanute and Galesburg would indicate a southerly dip. From Iola there is also a regular northern and western dip.

A half mile south of Galesburg we find twenty-five feet of sandstone and shales reaching to the bed of the creek. The connection of these with the Galesburg limestones was not seen and I was disposed to assign the sandstone to a lower horizon. But it may be possible that it is higher in the series and have a southern dip which has brought it into its present position. No local dip was observed, but if there is, it is then the equivalent of the Thayer flagstones. It is flaggy at both places

Sandstones do occur about forty feet below as well as thirty-five feet above the white limestone. At the railroad quarry, two miles north of Chanute, we find on the hill-top a bluish gray limestone. The sandstone below shows an outcrop of twenty-three feet including layers of good building stone. Three miles east and across the Neosho River the sandstone extends to the hill-top, and at the base of the hill we find the white limestone. There must, therefore, be about fifty feet of this sandstone in this vicinity. At the head of Chetopah Creek, half

way from Chanute to Thayer the sandstone crops out in thick beds. A similar sandstone has also been extensively quarried at Neodesha in Wilson County where it shows on the surface some remarkably interesting fucoids.

From this general view of the Neosho Valley rocks we pass to a special description of the Thayer coal.

The town of Thayer, Neosho County, is situated on the summit of a gently sloping ridge, descending eastwardly to a valley by a long and gentle slope, the same ridge descending more abruptly to the west. The highest rock at Thayer is a sandstone in flag-like layers. From the hill-top to the coal is fifty feet, the lower twenty feet of which is occupied by thinly bedded sandstone, the layers becoming much thinner near the coal and also more argillaceous.

The coal in the shaft is, when drifted on, from fourteen to eighteen inches thick. In some places the overlying sandy shales rest directly on the coal. When these shales are free from sand they often abound in fossil leaves of various plants, chiefly of ferns, some of them in an excellent state of preservation.

The coal is mined two to four miles south of Thayer, just west and northwest and six miles west, or over an area of about six miles square, employing in December, 1881, about 100 miners.

At Dickson's shaft the coal rests on four feet of underclay, below which the miners report a thin limestone layer resting on about twenty feet of clay shales. A half mile down the creek I observed a disintegrating limestone at six feet below coal. For two miles west I observed no marked change but observed a limestone in bed of creek at thirty feet below the coal. On the bluffs of the Little Chetopah Creek, in Wilson County, four miles southwest of Thayer, we find the coal separated by a clay band. Above the coal there is twenty-five feet of sandstone —the upper in thick brown beds, the lower in thin blue laminæ.

The coal is here divided thus:

10 inches—Coal.
6 inches—Blue clay shale.
6 inches—Coal.

The blue shale contains knife edges of coal. At Babcock's, six miles west and one mile south of the Thayer road, the coal is still divided, thus:

1. Thick bedded sandstone.
2. 15 feet thin bedded sandstone.
3. 5 inches coal.
4. 1 inch laminated clay.
5. 8 inches coal.
6. 6 inches laminated clay.
7. 6 inches coal.
8. 1 inch black laminated coaly shale.
9. 4 inches coal.
10. Fire clay.

Further in the drift we observed:

Coal, 6 inches.
Clay, 1 foot.
Coal, 10 inches.

One and a half miles north the coal is separated by five inches of blue clay shales, and a thin limestone band is insinuated in the overlying clay shales. Sandstone crops out above. Twenty-five feet below the coal we here observed layers of ferruginous limestone conglomerated in three layers of 6 inches, 4 inches and 8 inches with 4 feet of clay shales beneath. One mile still further north the coal and its associated rocks appear thus:

1. Thin layers of deep blue limestone.
2. 2 inches roughly bedded limestone.
3. 1 foot of drab calcareous shales.
4. 20 inches of deep ash-blue pyritiferous limestone, containing remains of *crinoideæ* including fragments of *Zeacrinus microspinus.*
5. 2 to 6 inches brown calcareous shale.
6. 10 inches coal.
7. 4 inches blue laminated shales.
8. 9 inches coal.
9. 2 feet fire-clay.

A quarter of a mile west observed as follows:

1. 4 feet blue clay shales.
2. 6 inches blue limestone.
3. 6 inches brownish gray calcareous shales.
4. 4 inches of limestone—No. 4 of last section.
5. 5 inches brown shale.
6. 9 inches coal with thin coal seams.
7. 4 inches blue clay.
8. 5 inches coal.

A quarter of a mile northwest we still find some changes with the following section:

1. 2 feet brown and drab limestone.
2. 6 feet of dark shale, the lower 1½ feet thinly laminated bituminous shales.
3. 0 to 1 foot blue concretionary limestone.
4. 10 inches thinly laminated calcareous shales and concretionary limestone.
5. 3 feet sandy and clay shales.
6. 6 inches blue clay shales.
7. 10 inches coal.
8. 4½ inches clay.
9. 6 inches coal.

We thus find that in passing west, the coal is divided by clay bands, and that beds of limestone become insinuated in the superincumbent shale beds. But the total thickness of the coal does not diminish. The fossil flora formed in the shales near the coal is peculiarly interesting including, as it does

Calamites—2 species. *Lepidodendron brittsii.* Lx. *Sigillaria. Neuropteris* 2 or 3 species, probably *N. loschii, N. hirsuta, N. rarinerois, N. angustifolia, Sphenopteris, tridactylies, alethopteris, serlii. Pecopteris squamosa. Annularia longifolia. Stigmaria, etc.*

In the sandstones above, good specimens can also sometimes be obtained of ferns, *Lepidodendron, Calamites* and *Sigillaria.* From the railroad we can see three noted mounds about seven miles northwest from Thayer. The highest is about 125 feet above the adjacent plain and ridge on which Thayer is situated, and is capped by broken layers of limestone. Other mounds can also be seen in the distance.

PLEASANT HILL, Mo., May, 1882.

PHILOSOPHY.

THE CAUSES AND CONDITIONS OF KNOWLEDGE.

BY R. J. M'CARTY.

There is a difference between the cause of a thing and the conditions which make it possible. Thus time and space are two of the conditions which make existence possible, yet they do not cause it. Therefore, when we have treated of a subject with reference to its causes, up to a point beyond which the human mind is incapable of proceeding, we may still inquire into its conditions.

The object of this paper is to treat of *knowledge* in this manner, viz:

To define the limits within which it may be treated as the effect of some cause.

To treat of the conditions of its possibility—conditions without which there could be no such thing as knowledge and which obtaining make all knowledge possible—and to show that neither the causes so far as traceable nor the conditions as developed indicate that any of our knowledge is innate.

Truth is possibility. Fact is possibility realized. Idea is a modification of mind produced in any manner whatever. Object is anything capable of producing idea. The act of consciousness is the culmination of mental effort.

Knowledge cannot be defined, for to do so would require a state of mind superior to that produced by its acquisition.

The utmost effort to discover the causes of knowledge must conclude that it results from an inexplicable operation of the mind called the act of consciousness,

(inexplicable because it lies above knowledge), by which the object producing an idea is recognized in its *true* relation to the nature of things. Therefore the act of consciousness marks the limit beyond which we may not proceed in inquiring after the causes of our knowledge The conditions necessary to the proper operation of this act of consciousness will therefore be the conditions necessary to the possibility of knowledge.

Now it is evident that no knowledge would be possible without the conditions of Fact or Truth, Mind, Idea and Consciousness: but these are not all the conditions necessary. There can be no knowledge without conviction, for no man can know a truth and not believe it, and if he fail to believe truth it is because he does not know it.

Still there may be conviction without knowledge—for instance, for a long time men believed that the earth stood still and that the stars revolved around it, and their conviction was as firmly established as if such had actually been the case. They certainly did not *know* that the earth moved, nor did they know that it stood still, for it did not. Therefore they knew nothing whatever about it. They were mistaken. Hence, we may say that conviction, without knowledge is error.

Again, the knowledge of no man is superior to his conviction nor is there any difference between the processes by which knowledge is gained and conviction established, because no man will investigate what seems to be a truth, further than to establish his conviction concerning it. If he stops short of conviction he will confess that he has gained no knowledge, but if he reaches it, it will be impossible to get him to proceed with his investigation until his conviction is shaken. And, furthermore, every man's conviction, though wrong, is the same to him as knowledge until he has found his error. From which it must follow that conviction results from the same act of the mind as that producing knowledge, with the difference, however, that the object producing an idea is recognized in a particular relation to the nature of things, which relation may be true or false. It is evident then that knowledge is impossible without *true* conviction.

Again, should the contemplation of different objects produce the same idea, we should not be able to distinguish one object from another, and should an object at one time produce an idea different from that produced at another, we should not be able to recognize it. So that in order for knowledge to be possible it is necessary that each object should always produce in the mind a particular idea and no other, and that this idea should be different from that produced by any other object whatever. This is the well known condition of Identity and Diversity of Idea, which involves both mind and object, and renders necessary an adaptation of the one to the other.

It will be seen that this condition does not require that the idea should represent the object just as it is—that is, the condition of Identity and Diversity will be fulfilled if the idea be either a symbol, or an image of the object, and hence arise those numerous disputes about the doctrine of perception into which philosophers enter by contradicting each other—seldom carry far without contra-

dicting themselves and which often end in useless wars over the meaning of words.

But to proceed—knowledge in general may be divided under three heads, Knowledge of Fact; Knowledge of Law and Knowledge of Necessity. Knowledge of Fact arises from the consciousness of those ideas produced in the mind by perception. Such knowledge is possible with the conditions of Fact, Mind, Idea, Identity and Diversity of Idea, the act of consciousness, and true conviction.

Knowledge of Law arises from a consciousness of the relations between facts and involves an action of the mind about its Knowledge of Fact which action, not being spontaneous, must be determined by something.

Now everything of which we are sensible must, we are compelled to think, be the effect of some particular cause or causes. This is called the Notion of Causality and is what prompts the mind to seek for the Knowledge of Law.

The process of reducing cause to effect must stop at a point immediately beyond which lies the absolute or unknowable, which has been demonstrated to be the one and indivisible cause of all that is. What the nature and attributes of the absolute may be is a theological question which does not concern this paper other than that it is the creator of law and the author of existence.

Now, whether this first cause may or may not be capricious we have no means of knowing and thus it happens that Knowledge of Law having for its basis the arbitrary will of the Absolute is colored with a feeling of dependence upon that will for its persistence. The conviction accompanying such knowledge is based upon the known constancy of this will in the past, but can never be pure unless we could know that this constancy could extend to all future time. And thus it happens that we are able to conceive all Knowledge of Fact, and with it all Knowledge of Law to become void. Hence those sciences which have the Knowledge of Fact for their basis, and which are but the Knowledge of Law systematized, such as mechanics, natural philosophy, chemistry, etc., are all dependent upon the uniformity and persistence of natural law. We see therefore that in addition to those conditions necessary to a Knowledge of Fact, a Knowledge of Law could not be but for the Notion of Causality and would be impossible unless nature is uniform.

We now come the Knowledge of Necessity. Necessity is that which must be and which being it is impossible should not be. It must, therefore, be independent of fact and (so far as we can know) independent of the will of the Absolute, and must persist if persistence is possible.

Now *propositions* which are independent of phenomenal existence are true if they are possible. Their truth determined renders their falsity impossible, and we cannot conceive them to be dependent upon any contingency for their persistence. Take the proposition "things which are an equal to the same thing, are equal to each other." While the practical application of this truth depends upon existence, the truth itself does not, nor can we conceive it possible that the universe could be wiped out and rcreated without this proposition reasserting itself.

The case is different with natural law. For instance, the law of gravitation would vanish with matter but need not reappear with it.

Propositions which are independent of existence, in the sense just illustrated, are therefore emblems of necessity, and our knowledge of necessity must result from the determination of the truth or falsity, or what is the same thing, the possibility or impossibility of them. Now these propositions are of two kinds: knowable and unknowable. It will, therefore, be necessary to distinguish them.

No one can conceive of an impossible thing, and whosoever thinks he can will find by reflection that his conception is of something which is not, in his opinion, likely to happen. For instance we can conceive of the Gorgon's head, the winged horse and the golden fleece and such things are possible, but by no means probable. Still, possibility is not limited by conception.

Take the proposition "space is limited." We cannot conceive of a limit to space without conceiving of space beyond that limit. We cannot conceive of space as boundless, for we cannot conceive of infinity. Yet we know that space is either limited or it is not. The proposition is unknowable, and so is *any* proposition neither extreme of which is conceivable. Again, these propositions, being either true or false, there cannot be one of which both extremes are conceivable because one must be impossible. The only propositions, therefore, which are knowable are those of which one extreme is conceivable, the other not.

(This is substantially the Principle of the Conditioned as enunciated by Sir William Hamilton.)

Knowable propositions are of two kinds, self-evident and demonstrable, or to be less general, axioms and theorems. Axioms are called self-evident because the mind comes by the knowledge of them apparently without effort.

Now since these propositions, as well as the human mind, may be regarded as independent of phenomenal existence, it was thought necessary by many philosophers to account for the knowledge of necessity as it obtains with us, just as they would, did there exist nothing but mind and truth. This view, of course, necessitated a relation between mind and truth which would be independent of fact, and as it was impossible to see how the mind could be affected by abstract truth except through the medium of fact, many philosophers got rid of the difficulty by assuming the ideas of axioms to be innate. But it would do just as well to assume that these propositions in some unknown way affected the mind and it would be more philosophical.

Still, in either case, more would be assumed than could ever be proven. To deal with this question it must be treated just as it is presented to us, and in this aspect we will endeavor to find the conditions of the possibility of necessary knowledge. It cannot be denied that we *could* gain the knowledge of axioms just as we do the knowledge of law. Nor can it be denied that we get the knowledge theorems by reasoning from axioms in precisely the same manner that we get the knowledge of law by reasoning from fact.

Moreover, the notion of causality is as necessary to the knowledge of theorems as it is to the knowledge of law. So that if we for convenience deprive

axioms of their attribute of necessity (which will in no way invalidate our reasoning) and place them in the category of natural laws where, in fact, they would then belong, knowledge of law and knowledge of necessity would become identical and the conditions of the one would become the conditions of the other. This shows that the knowledge of law and the knowledge of necessity may be obtained under the same conditions, and that since no one ever held the ideas produced by facts to be innate, those produced by axioms should not be so considered.

The only objection to this conclusion would be that in order to reach it it was necessary to reduce axioms to the category of natural laws, where they do not belong and that if we restore their attributes of necessity we would get a knowledge different from the knowledge of law. This is true, but by what is the difference determined? The answer is by a difference of conviction alone.

Giving back to axioms their attributes of necessity and we find the only effect is to strengthen our conviction of their truth so as not to be shaken by anything of which we can conceive. It only remains to account for the manner in which the mind becomes possessed of this distinctive conviction. We have shown that a proposition to be knowable must have one of its extremes conceivable, the other not.

Now the question "Is a proposition knowable?" is as important as the question "Is it true?" for our criterion of truth cannot be higher than our criterion of the limits within which truth may be investigated.

Whence the following enunciation: When the mind can conceive of the possibility of a proposition which is independent of existence and cannot conceive of its impossibility, the proposition is knowable and possible and true. This then is the mind's criterion of truth. But since we may imagine ourselves to conceive when we do not and fail to conceive when we can, the following is also true: When the mind has apparently conceived of the possibility of such a proposition and apparently cannot conceive of its impossibility, the proposition may be knowable or unknowable possible or impossible, true or false Knowable, possible and true if the conception is real, unknowable or impossible and false if the conception is imaginary. From which it would seem that the criterion enunciated is of little value.

But granting it to be fallible, it is still sufficient to establish in the mind that peculiar conviction which accompanies the knowledge of necessity and by which alone such knowledge is distinguished. Because necessary propositions are such that their possibility determines their truth. So that whosoever conceives the one must conceive the other, and no man can conceive such a proposition to be true and not believe it—and moreover he cannot then conceive the proposition to be false. It is thus therefore that the mind gets its distinctive conviction of necessary truth. It is by this conviction that knowledge of necessity is recognized as such, so that without it all our knowledge would be as of one kind.

In support of what has been said can be cited the credulity of the untrained mind which often accepts as truth the uttermost absurdity. The caution of the

trained intelligence which often runs to extreme skepticism, and the fact that none of the results of reasoning from either axioms or facts can ever be entirely emancipated from the probability of error. All of which while pointing to the fallibility of the mind's criterion of truth indicates its nature.

It therefore seems reasonable to conclude that the mind gets its ideas of necessary truths through the medium of *fact* somewhat as it gets its idea of a true through the medium of light, and as the sense of touch would prove the true to exist in the absence of light, so the criterion laid down would prove truth to persist in the absence of fact; that the knowledge of necessity is known only as such by the peculiar conviction accompanying it; that this conviction is a condition of the knowledge of necessity being recognized as such but is not a condition of its possibility; and that innate ideas are not to be found among the causes and conditions of knowledge, and, hence, do not exist.

CORRESPONDENCE.

SCIENCE LETTER FROM PARIS.

PARIS, June 3, 1882.

M. Loyet has published a very remarkable work on the Health and Disease of the Peasantry, contrasting those of France with the rural populations of other countries. The author commences by studying the influence of soil and the nature of land. Marshy districts play the most important role in the question, and are of three classes: those connected with the seaside, the offspring of rivers, or inland lakes. On the shore of the Mediterranean, from Nigues-Mortes to Perpiguan, the death rate is very high; there are localities where the mean average of life hardly attains the two-thirds of the total rate for all France, namely:—24 instead of 36 years. There are also some agricultural industries which necessitate veritable marshes, such as the cultivation of rice, and the steeping of flax and hemp. These bring about an alteration of water and air.

On the west coast of France, there are extensive salt marshes to the deleterious influences of which the population has to submit. Then there are also extensive bogs. In the country, the inhabitants are more affected by the influences of the soil than in the case of towns; in the latter, the state interferes to connect the insolubrity and encourages hygiene. The dwellings of the peasantry are a fruitful source of disease; in the most smiling districts of France, where vegetation is most vigorous, the peasants' houses will ever be found to be next to buried in the soil, and deprived of almost openings. It is the same picture for all France; the rooms serve for every usage, and between the accommodation for the inhabitants and the domestic animals, the separation is but slight.

In the mountainous regions of the Alps and the Iura, the cottages are miserable, they are constructed in wood, covered with green turf, with an aperture at the top for chimney and ventilator. The residents live in an atmosphere of smoke. At the sides of the hut are annexes filled with dry leaves or maize straw; these form the bed-rooms. On an opposite side, the domestic animals are housed, but only for the night. M. Loyet attributes the principal cause of the insolubrity of rural habitations to their defective walls, which permit humidity to enter. The thatched roof he admits may be thick and solid, but it rots quickly, and is the refuge for horrible worms. The earthen floor is objectionable, and wherever one in wood, tiles, or flags can be laid down, it ought first to have a sub-stratum of broken stones and mortar. a concrete bed in fact.

The dwellings are invariably overcrowded, and the rarity of windows is the natural consequence of the baneful tax on doors and windows. The average "openings" per each house-occupant, is for fifty-three more than the one-half of the departments of France, a little above one, and, as this sad condition exists chiefly in the rural districts, disease follows regularly in the wake of habitations so constructed. Respecting manure heaps and fœcal drainage, it is the old story. As to the dietary of the peasants, it is very defective; the bread is too often mouldy; but then there are localities where it is baked for months in advance. Ordinarily the regimen is maize, oat meal, buckwheat and millet, and consumed in the form of porridge. When the grain is diseased, as in the case of ergot rye, the consequences can but be deplorable, but damaged maize produces the malady of *pellagre*, only second in point of disaster, as Lombardy and Venetia can testify. In reference to *pellagre*, misery is not the cause of the scourge, but rather a favorable medium for its development. It is unknown among the poor of Ireland and Silesia, and is due, according to Professor Lombraso, to degeneracy of the grain, caused by parasitical mushrooms, and that induce the formation of a toxical alkaloid.

Being rather accustomed of late to the visits of comets, may explain why no very marked interest is taken in the present visitor. It travels at the daily rate of three millions of miles, nearly double that of our earth's diurnal rotation round the Sun. Its tail, always foremost, turned toward the Sun, like every comet's, presents the form of a plume of feathers, and is estimated to be 600,000 miles in length. Other comets have had tails from 120,000 to 240,000 miles long. However, the tails are only rays of light, transparent and imponderable. Spectral analysis has shown that carbon and hydrogen are the predominating elements of such luminous volumes; were they to affect the constitution of our atmosphere, the result would be grave; a diminution in the proportion of oxygen, would plunge us into a state of heaviness and lethargy, while an augmentation would bring about a condition of exhilaration and nervous excitement, caused by the rapid combustion of the blood in the lungs and arteries, not less fatal. No fear is to be apprehended under the head of a collision, the comet is not a "star of terror." Some comets have attained one million and a half miles in diameter; that of 1811 had a tail

one hundred and thirty-two millions of miles. But density is wanting, and so they could not make an incursion into our atmosphere. However, they have been launched with such a formidable velocity, and their temperature is so elevated, since their elements are in a state of incandescence, that some of their *noyaux*, or kernels, have appeared composed of an aggregation of aërolites immersed in a burning gas. If a rencontre took place, though it would not be mortal, it would certainly not be inoffensive.

The role of comets in the universe is still an enigma; they seem to be an exception in the general harmony of the movements of the heavenly bodies. Do they voyage from one star to another, or do they circulate from systems to systems? Some in traversing our planetary system have been attracted by the power of Jupiter. Saturn and Uranus remained captive, a permanent addition to our solar world. If a comet escapes the sphere of planetary influence, it will travel during eternity in the void of ether. It is presumed that comets are some nebulosities abandoned at the commencement of the solar world, some external scraps of that primitive nebulosity of which the sun, the earth, and planets are the condensations. The central-fire of our system attracts them, they flit round it as moths around a flame. Other comets may have originated from other systems, ruins, representatives of "the wreck of matter and the crush of worlds." Kepler believed, that comets were as numerous as the fish of the sea. Analysis of cometic light reveals it to be analogous to that of the flame of alcohol, that is to say, contains the elements carbon, hydrogen and oxygen, the primordial constituents of organic life. If the comet has come from the nearest star, that represents a traveled distance of twenty-four thousand millions of miles.

The angry discussion taking place respecting the addition of alcohol and sugar to wine, presents so many scientific features, as to merit examination. The wines produced in many regions of France, and notably the south, are liable on account of the large quantity of sugar they contain, to undergo after being placed in hogshead, to a new fermentation, which profoundly alters their character. The addition of alcohol stops this fermentation, and so enables the wine to be exported to distant countries. In the preparation of artificial wines and liquors the fermentation of the must is stopped, in order to conserve the natural sugar of the grape; then alcohol is added to impart body. Not a few vineyard proprietors employ sulphur for this process but it is less efficacious and unhealthy. The addition of sugars to the must, augments the alcoholic richness of the wine, since fermentation of the sugar yields the spirit. Increasing the alcoholic strength of wine not alone imparts to it the qualities of generosity and conservation, the process diminishes also the acidity of the wine. Tartaric is the dominant acid in wine, but it is combined with potash, under the form of bitartrate, and which is precipitated in the form of crystals on the sides of the hogsheads. Now the solubility of that acid in wine, diminishes in proportion with the quantity of alcohol present. Further, as the coloring matters of wine are more soluble in alcohol than in water, the addition of alcohol develops the color of wines.

But this important point must be kept in view; if it be intended to add sugar to a must poor in that substance, the sugar ought to be of the same nature as that peculiar to the grape. Now, crystallized beat-sugar supplies this want. In a year when the sun's heat and light are defective, the grape is deficient in sugar but rich in acid; hence, the addition of beet or cane sugars supplements an absent sun; that sugar ferments in the same conditions and produces the same alcohol as the natural sugar of the fermenting fruit. Glucose, that is syrup prepared from maize or wheat, is wholly unsuitable.

After a first fermentation, and a drawing off of the wine so resulting if more sugar be added to the contents of the vat, an excellent second, and even a third small wine can be prepared, called *piquette*. Vineyard proprietors with good brands assert, the wine industry of France will lose its reputation, and will cease to be remunerative, if facilities are afforded to manufacture wines, by conceding latitude to add alcohol directly, or indirectly by the use of sugar to induce extra alcoholic fermentations.

HISTORICAL NOTES.

KANSAS IN 1786.

BY J. R. MEAD.

Any facts bearing upon the early exploration, or history of Kansas or the Missouri Valley, should be carefully collected and preserved in some form accessible to the future historian; I therefore give the REVIEW an item which possibly may be of interest.

In the spring of 1860 I was in camp upon the north bank of the Smoky Hill River, about two miles east of Cedar Bluff as then known in what is now the county of Ellsworth, and some forty miles west of Salina, Kansas. The south bank of the river was a steep bluff of sandstone from the summit of which the table land extended back to the divide. While hunting buffalo upon this table-land I noticed quite a deep ravine extending a mile or more back, with a number of lateral branches, and apparently emptying into the river nearly opposite my camp. Not having noticed any opening in the bluff I concluded to follow the ravine to its outlet, and, to my surprise found it ended in a cave about two hundred feet from the river which was as far back as the sandstone extended. On entering this cave I found it had been formed by a small stream of water running from the table-land over the bluff, and in time cutting a narrow, crooked channel from one to two feet in width down to the level of the river, and in course of ages it had widened out at the bottom into considerable chambers, and the soil from the ravine had washed through it into the river.

As soon as my eyes became accustomed to the imperfect light of the cave I discovered its walls were covered with hieroglyphics and representations of all the animals common on the plains, and others to me unknown, also battle scenes and figures of men with an arrow across the body. The figures of men were made with a triangle for the head, and another for the body. These figures appeared of great age, many of them overgrown with moss, and were ruder and different from the representations of men and animals made by the wild tribes of the plains at that time.

While studying these interesting characters, to my surprise I saw letters in a language I could understand, and on rubbing off the moss there stood revealed, carved by the hand evidently of an educated man, the name and date "TVREDO, 1786." The letters and figures were about an inch in height, of beautiful proportions, and of uniform size and slope. I could discover no other evidence of civilized man having visited the spot.

A careful examination of the cave at this spot satisfied me that the walls had remained in the form I then saw them unchanged, perhaps, for centuries. On going around to the river outlet of the cave, I found the walls covered with hieroglyphics, but not in so perfect a state of preservation. I intended to make a sketch of the representations on the walls and to explore further in the dark and crooked recesses of the cave, but on the second night we heard the distant sound of drums up the river, and on going to the top of Cedar Bluff saw the valley lighted by the camp-fires of the wild Indians. Hastily gathering up our effects we drove rapidly down the river, and I have not visited the place since.

Will some tell us who Mr. "TVREDO" was and what he was doing in the heart of Kansas in the year 1786.

TREATIES WITH INDIAN TRIBES FOR LAND IN MISSOURI.

BY JOHN P. JONES, KEYTESVILLE, MO.

Within a year after the treaty of peace with Great Britain in 1783, our Government began a system of treaties with the various Indian tribes living in its territory with a view of definitely locating the districts in which they should be allowed to live and hunt unmolested, and rendering them a compensation for the territory which they relinquished to the whites. After the acquisition of the Louisiana purchase in 1803, a part of the area of which, is embraced in the State of Missouri, the Government continued its treaties with the Indian tribes claiming rights and privileges therein, realizing that it owed a duty to the hardy spirits who were pushing across the Mississippi, to bring to their firesides as much as possible, a sense of security from Indian attacks, that they might be the better enabled to prosecute the development of the newly acquired country.

Our State historians have universally omitted any reference to these treaties by the Government for the friendship of the Indians, and the extinguishment of

their claims on our lands, though they were of first importance to our pioneers, securing to them, as they did in a great measure, immunity from midnight assaults and depredations, and the restoration of friends held as captives, and property previously stolen.

Were it not for benefits of this nature there would be something ludicrous in our Government solemnly treating with the tribes that it did, for that portion of our State lying north of the Missouri River. They had driven the Missouris, lately scourged by an epidemic, from their homes, and were claiming the country from their ability to hunt over it and raid through it, owing to the near location of their villages to its borders. This claim, however, was prudently acknowledged and treated for by the Government on three different occasions. The first treaty for any part of our State north of the Missouri River, was negotiated at St. Louis, Nov. 3, 1804, by Wm. H. Harrison, Governor of the Territory of Indiana and superintendent of the Indian affairs for that territory and the district of Louisiana, on the part of the United States and five chiefs of the Sac and Fox Indians for their tribes. The second article of this treaty stipulates that "the general boundary line between the lands of the United States and of said Indian tribes shall be as follows, to-wit: beginning at a point on the Missouri River opposite to the mouth of the Gasconade River, thence in a direct line so as to strike the river Jeffreon at a distance of thirty miles from its mouth and down the said Jeffreon to the Mississippi, thence up the Mississippi to the mouth of the Wisconsin River, and up the same to a point which shall be thirty-six miles in a direct line from the mouth of the said river, thence by a direct line to Fox River branch of the Illinois, thence down Fox River to the Illinois, and down the same to the Mississippi."

By this treaty the Government acquired the eastern portion of the State lying north of the Missouri River, the northwestern part of Illinois and the southwestern part of Wisconsin. The consideration paid was $2,234.50 in goods paid down, and the promise of $1,000 worth to be delivered at St. Louis, yearly. Among the chiefs who signed this treaty were Jumping Fish, Sun Fish and Bear. This treaty was assented to or re-ratified at Portage des Sioux, St. Charles Co., Missouri, on the 13th day of September, 1815, William Clark, Ninian Edwards and Auguste Chouteau acting as commissioners for the Government and thirty-four Sac and Fox chiefs on the part of these tribes, among them Big Eagle, Sturgeon, The Devil, and He-that-Stands-by-the-Tree, of the Sacs, and Sur, Quick Riser, Scenting Fox, White Skin and others of the Foxes. The object of this ratification was to re-establish the peaceful relations existing between the parties thereto, prior to the war of 1812, which had been disturbed by emissaries of Great Britain.

The Sacs and Foxes who had been parties to this treaty and to its subsequent ratification were a division of these tribes that had removed from Wisconsin, across the Mississippi and hunted from that river to the Missouri. On the 13th day of May, 1816, the Sacs and Foxes of Rock River, Wisconsin, entered into a treaty of assent and ratification of the treaty of 1804 at St. Louis, Mo., confirming that and all other contracts and agreements heretofore made between

the tribes and the United States. Messrs. Clark, Edwards and Chouteau were the commissioners for the Government, and the Indians were represented by The-One-Who-Speaks, Jumping Sturgeon, Bad Axe, Bad Weather, Swan-Whose-Wings-Crack-When-He-Flies, and others. No consideration was expressed in the terms of this ratification and none paid except presents to the chiefs who were parties to it.

The treaty of 1804 and its subsequent ratifications contributed with other causes, to bring on the Black Hawk War. That warrior contending that the chiefs who were parties to it in 1804 had separated from the nation and consequently were without authority to act, and that those who ratified it in 1816 received no compensation and their assent to it was obtained while they were under the influence of liquor.

Eight years after this last ratification a party of Sac and Fox chiefs and head men fully deputized to act for and in behalf of their said nations, visited Washington, D. C., in company with deputations from other tribes and negotiated another treaty with the Government represented by William Clark, Superintendent of Indian Affairs.

Article first stipulated that the Sac and Fox tribes cede, relinquish and forever quit claim unto the United States all right, title, interest and claim to the lands which the said Sac and Fox tribes have or claim without limits in the State of Missouri which are situated lying and being between the Mississippi and Missouri Rivers, and a line running from the Missouri at the entrance of the Kansas River, north one hundred miles to the northwest corner of the State of Missouri, and from thence east to the Mississippi.

This conveyance it will be seen includes all the territory of the present State of Missouri, north of the Missouri River, and the Government agreed to pay as a consideration fifteen hundred dollars in cash and one thousand dollars for ten years. Among the chiefs who were parties to this treaty were All Fish, Crouching Eagle, Wrathful Fox, Rising Cloud and White Nosed Fox.

This treaty ended the dealings of the Government with the Sacs and Foxes for Missouri territory, and when we consider the slight claims they had to the country conveyed, we cannot help concluding that the consideration paid was more in the nature of a bribe to induce good behavior than for value received. These Indians were interlopers on any territory west of the Mississippi, they being of Algonquin stock and had made their home for centuries about the great lakes. When first known to the whites their home was near Lake Erie on the Canada side. About the year 1650 they moved west and located near Lake Michigan, finally settling on Fox River and its tributaries in Wisconsin, where they remained for a century and a half. Here they were found in 1670 by Father Allonez, the Jesuit missionary, who says in his relation of that year, "The 16th day of April I embarked to go and commence the mission of the Outagamies (Foxes) a people well known in all these parts. The 17th we went up the river St. Francis, and after having advanced four leagues we found the village of the Indians named Saky (Sacs). The 20th we arrived in a river that came from a lake of wild rice which

we came into and at the head of which we found the river which leads to the Outagamies." Father Allonez found the Indians very much dejected on account of the loss of several of their families who had been captured near Lake Michigan by a party of Iroquois warriors.

From this date these Indians are freqently mentioned by the early explorers of the lake country. In 1671 their chiefs were present at the congress of tribes at Mackinaw when St. Lusson took possession of the west in the name of the French king. In October, 1679, Hennipin and LaSalle met a party of them on the south shore of Lake Michigan, and two years later Hennnpin passed through their villages on Fox River, when returning from captivity among the Sioux. LaSalle visited their villages in 1681 in search of his men who had been driven from the Illinois country by the Iroquois, and heard from them of the safety of Tonty and the others. Father Charlevoix, the celebrated Jesuit who traveled through Louisiana in 1720-1, spent some time with the missionaries among these Indians in 1721, and urged the Sacs to greater respect for their Missionary if they hoped to retain the favor of the French King. Jona Carver the first prominent native American traveler in the west, was among these Indians in 1766 and mentions that one village of the Sacs could furnish three hundred warriors.

There was nothing in the character of the Sacs and Foxes in any way differing from the other Indians of the west and in an intercourse of one hundred and fifty years with the whites, Black Hawk is their only warrior that has won distinction.

But the Sacs and Foxes were not the only Indians who claimed an ownership in Missouri. The Ioways put forward a claim to the country and on the 4th day of August, 1824, the Government entered into a treaty with them at Washington, D. C., by which it was agreed that the Ioways cede forever quit claim and relinquish to the United States all the right, title, interest and claim to the lands which the said Ioway tribe have or claim within the State of Missouri and situated between the Mississippi and Missouri Rivers and a line, which has been run and marked by Colonel Sullivan, running from the Missouri, at the mouth or entrance of the Kansas River, north one hundred miles, to the northwest corner of the limits of the State of Missouri, and from thence, east to the Mississippi. The consideration paid the Ioways was five hundred dollars in cash and the promise of five hundred dollars to be paid annually for ten years. They were represented by Mah hos-kah, or White Cloud, and Mah-ne-hah-nah, or Great Walker, and this was the first treaty with the tribe in which they disposed of any land.

This tribe had more right to treat for the disposal of Missouri territory than the Sacs and Foxes. Their hunting-grounds were on the water-courses that flowed to the Missouri River and they frequently made incursions into the territory when the Missouris held sway there, they were of the great Dacotah family whose natural home was west of the Mississippi, and they assisted in driving away the remnant of Missouris, hence their claims may be said to have had some foundation.

Of the many perversions and changes that have taken place in the names of our Indian tribes, that of Ioway, (or Iowa, as now spelled), is not more marked than that of many others but an explanation of this instance will serve as an index to the many errors with which our Indian nomenclature is crowded. The word Ioway has been made up from the Dacotah designation of the tribe, Ayuliapa, by taking the first two syllables Ayu, and adding to it one of the common French terminations to tribal names, either *vois*, *vais*, or *ouez*, as this was the manner in which the name first appears in early French annals. For instance in LaHarpe's narrative of LaSuer's expedition to the Blue Earth region in 1700, they are mentioned as Ayavois; in Penicant's narrative of the same expedition they are called Aiavos. Charlevoix in his History of New France, 1722, speaks of them as Aiouez. On the map of De Lisle, published at Paris, 1703, in what is now the State of Iowa, on a small stream an Indian camp is represented with the following legend, "Village des Aiaoues on Pantez." One hundred years later Lewis and Clark mention them as Ayauways. Lieut. Z. M. Pike who ascended the Mississippi in 1805, mentions that the Aiowais were called Nez Perce by the French, which means pierced noses, but why he does not state, nor is it true that this tribe were more in the habit of wearing ornaments in their nose than others.

The name which the Ioways gave themselves is Pa-hutchae, which means dusty heads. The prefix "Pa" anciently signified head, and the origin of the name is accounted in the fact that they lived for many years on the Upper Missouri and were accustomed to bathe in its yellow muddy water, and when they dried off after coming out, the sediment of the water remained on their heads making them look dusty and gray.

The first mention of the tribe is found on Marquette's map drawn in 1673 where under the name Pahutet they are located as living on the Missouri above the Omahas and Otoes, and which was their location until the establishment of French posts on the lakes and near the Mississippi drew them east for the purpose of trade.

The friendly relations existing between the Sacs and Foxes and Iowas at the beginning of the present century did not date back to the time when the tribes first became known to the French. Under date of July 10, 1700, Father Marest of the Jesuit Mission on the Illinois, wrote to Le Suer as follows: "I have the honor to write in order to inform you that the Sauks (Sacs) have been defeated by the Sioux and Ayavois. These people have formed an alliance with the Kickapoos, Mecoutins, Foxes and Metsegamies and have gone to revenge themselves, not on the Sioux for they are too powerful, but perhaps on the Ayavois, or more probably upon the Osages who suspect nothing.

BOOK NOTICES.

APPLETON'S ANNUAL CYCLOPÆDIA. Vol. XXI, 1881. Octavo, pp. 905; cloth, $5. For sale by L. B. Bailey, General Agent, Kansas City, Mo.

This is the sixth volume of the new series, and the twenty-first of the whole series. The publishers truthfully and aptly say, "It has grown in size to meet the increased activity in human affairs and to present the interesting public questions and scientific developments which have arisen and the discussion of their principles."

Among the historical subjects presented, none is more interesting at the present time than the summary of the Garfield assassination; the trial of Guiteau; the discussion of the insanity question; the history of the treatment of the President's case, etc. All of the stirring events in South America, Russia, Germany, France, Italy and Spain, are carefully summarized under proper heads by the most competent writers.

The progress of science is given with unusual minuteness and accuracy, whether in chemistry, philosophy, engineering, electricity, physics or zoology.

The results of the 10th Census are given a large space and illustrated with reduced copies of the maps showing density of population, native, colored and foreign.

Four fine steel portraits, as usual, embellish the volume, viz: Longfellow, Blaine, President Arthur and Gambetta, in addition to which are numerous maps and other illustrations.

No book or publication of any house in the United States equals this in value or importance to the reading public. Each volume brings the world's history forward in a convenient, comprehensive and strictly reliable form and at a price within the reach of all classes.

GATEWAYS TO THE POLE. By Silas Bent. 8vo. pp. 40; R. P. Studley & Co., St. Louis.

This address was delivered before the St. Louis Mercantile Library Association upon the thermal paths to the pole, or the currents of the ocean, and shows the influence of the latter upon the climates of the world. The author speaks of the currents of the ocean with all the naturalness and vividness of a voyager, and the reader can almost see them pouring their mighty floods toward the Pole. The address gives a valuable sketch of the explorations and discoveries made in the Arctic Seas since 1868. The main object of the lecture is to show that the ocean currents open the natural highways to the Poles, and should be followed by the Arctic explorers if they would attain any substantial results. The theory is well

expressed in the closing paragraph as follows, where the author says: That the Gulf Stream and Kur-Siwo are the prime and only cause of the open sea about the Pole, with its temperature so much above that due to the latitude; that the only practical avenues by which ships can reach that sea, and thence to the Pole, is by following the warm waters of these streams into that sea; that to find and follow these streams, the water thermometer is the only guide, and that for this reason they may be justly termed the "Thermometric Gateways to the Pole."

WORMS AND CRUSTACEA. By Alpheus Hyatt; pp. 68. Ginn, Heath & Co., Boston, Mass, 1882.

This is one of the publications of the Boston Society of Natural History designed to supplement lectures given to teachers of the public schools of Boston.

This is the eighth number of a series of ten publications or pamphlets on scientific studies designed for teachers. Besides simple illustrations and instructions as to the modes of presentation and study, there are, in each pamphlet, hints which will be found useful in preserving, preparing, collecting and purchasing specimens. These publications ought to be in the hands of every teacher who loves nature, and if one does not love and study nature, is he fit to teach?

WANDERINGS IN SOUTH AMERICA. By Charles Waterton, 8vo. pp. 64. MacMillan & Co., London, 1882.

In this publication we have the wanderings of a naturalist in South America, the northwest of the United States and the Antilles, in the years 1812, 1816, 1820 and 1824 with original instructions for the preservation of birds, etc, for cabinets of natural history.

There is a biography of the author by the Rev. J. G. Wood, and an explanatory index by the same. This publication is chiefly valuable as a work of history. In the last fifty years there has been much progress in natural science. The narrative is quite interesting to the reader.

PROCEEDINGS OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA. Part I, January to April, 1882. 8vo. pp. 104.

This publication contains fifty-six papers, illustrated by several charts. The papers are thoroughly scientific in character and very valuable.

HORSES' TEETH. By William H. Clarke. 12mo. pp. 262; New York, 1880. $1.

This is a treatise upon the teeth of horses, their mode of development, physiological relations, anatomy, microscopical character and pathology, made up from the works of Profs. Owen, Huxley, John Hunter, Dunglison, Youatt, Chau-

veau, Percivall, Tomes, Gamgee, Leidy and others, and will be found a very useful and readable compilation of authorities upon all the topics above named. It is also valuable for its practical suggestions concerning various diseases of horses' mouths and teeth, and especially for a vocabulary of thirty pages defining all the technical terms ordinarily used in scientific works upon the subjects treated.

The student of comparative anatomy, as well as the veterinary surgeon, will find much of interest to him in this work and will be put upon the track of much more by the copious quotations from notes and references to the noted authors named above and many more of equal standing.

OTHER PUBLICATIONS RECEIVED.

The Reduction of Air-Pressure to Sea Level, at Elevated Stations West of the Mississippi River, by Henry A. Hazen, from Signal Bureau; Publication No. 5. by Samuel Gaty, Missouri Historical Society; *Chemical Review and Journal*, Chicago; *The Peoria Medical Monthly;* Catalogue of Missouri University for and 1881–2; Annual Report and statistics of the Meteorology of the City of Oakland, Cal., for 1881, by J. B. Trembly; Notes on the Mineralogy of Missouri, by Alexander V. Leonhard; *Northern Indiana School Journal* for June, 1882, Valparaiso, Ind., $1.25 per annum; Hints for Painters, Decorators and Paper-Hangers, New York Industrial Publication Co.; Publication No. VI, Archæoloogy of Missouri, by F. F. Hilder, Missouri Historical Society; Hereditary Traits and other Essays, by R. A. Proctor, Humboldt Library, New York; Vignettes from Nature, by Grant Allen, New York; The Kansas Kikkabe, 1882, Lawrence, Kansas; *The Kansas Review*, June, 1882, Lawrence, Kansas; A New Method of Bright-Wire Illumination for Position Micrometers, by S. W. Burnham, Esq.; Catalogue of the Univerisity of New Mexico, 1881, Santa Fe, N. M.; Catalogue ot the Bookwalter Engine, New York.

Prof. Morangoni shows by a conclusive set of experiments that moist air is not a conductor of electricity. He proves that the loss of current in telegraph wires and the want of action in electrical machines during misty or wet weather is due to the condensation of moisture, carbonaceous deposits, adherent dust, spiders' webs or the contact of branches of trees.

The silk industry is reviving in Louisiana, the news of this spring's hatching being very encouraging. Interest in the culture is growing, and inducements are offered to silk workers to come from France and engage in the business. The first exports of silk from Louisiana were made as far back as 1718. The culture of silk is also being revived in South Carolina and Georgia.

SCIENTIFIC MISCELLANY.

THE THUNDER-BIRD.

AN INDIAN LEGEND, BY WM. H. R. LYKINS.

It is believed by some of the Indian tribes that thunder is caused by a great bird, which has its home in the skies. The sound, they say, is caused by the flapping of its wings as it revels in the storm cloud sweeping over the earth. In connection with this bird they tell the following story:

An Indian hunter was one day returning from a visit to his traps. On his back he carried two beavers which he had taken, tied together with strings of bark. In his hand he carried a long hunting spear. As he was walking quietly along something like a dark cloud suddenly over-shadowed him, and looking up he saw an enormous bird swooping down upon him. Before he could place himself in an attitude of defense, he was grasped in its talons and borne rapidly upward. Soon the tall trees dwindled into shrubs, next the high hills faded away, and finally the whole earth disappeared. Upward and onward through space the bird carried him until there appeared far in the west a long range of lofty and precipitous cliffs Toward these cliffs the bird directed its flight, and having reached them, sailed slow and heavily along their sides. At times she would dash the hunter violently against the rocks, but with his spear which he still retained, he warded off the blows and escaped unharmed.

At last they arrived at the mouth of a great cavern into which the bird threw the hunter and disappeared. He lay stunned by the fall until aroused by an unearthly shriek, and lifting his head he saw in one corner of cavern a young thunder-bird which was now clamoring for its noonday meal. Hastily untying the beavers from his back he threw them to the bird which swallowed each one of them at a gulp, then quietly settled back in its nest. The hunter now took a view of his situation. The floor was strewn with the bones of deer, wolves and great serpents, with here and there a grinning human skull which seemed to mock his helplessness and remind him of the terrible death which awaited him. He approached the mouth of the cavern and looked out. Far away on either hand stretched that wall of rock, lonely and desolate. Not even a blade of grass could find a resting-place on its steep and sterile sides; not even the hum of an insect or the chirp or a desert cricket broke the oppressive silence. Above and below were the awful depths of blue.

There seemed to be but little chance for an escape from such a place but the hunter was one of the bravest of his tribe; tried in many times of danger and not one to despair while life remained. Approaching the young bird which was now

quietly sleeping after its lunch of beaver, he plunged his keen hunting-knife into its throat, killing it instantly. Then making an incison in its breast he carefully drew through it the body and thighs, leaving the skin intact. Next he stretched the wings out to their full length and in this position bound them firmly to the shaft of his spear with the strings which had held his beavers. His arrangements were now complete, and dragging the skin to the mouth of the cave he crawled into it leaving his head protruding from the hole in its breast and boldly leaped off into space. His project was a complete success, and to his great delight he found himself slowly descending in graceful circles toward the earth. He alighted in safety and taking two of the feathers of the bird—as much as he could carry—he started homeward, and on the evening of the third day after his capture he was seated before his lodge relating to his friends his wonderful adventure.

Often as the traveler journeys over the western plains he will see a tall column of dust suddenly rise and after whirling along a short distance as suddenly disappear. This the Indians say is caused by the "Thunder-Bird," who, when she descends to snatch a serpent for her young thus conceals herself from mortal sight. And sometimes when the air is pure and the skies are clear the Indian thinks that far away in the western sky he can see that place to which the hunter was borne and from which he so miraculously escaped—perhaps some summer cloud which lies weltering upon the horizon which his "untutored mind" imagines is the rocky home of the "Thunder-Bird."

CHARLES DARWIN.

BY JOHN FISKE.

It is fitting that in the great Abbey, where rests the ashes of England's noblest heroes, the place of the discoverer of natural selection should be near that of Sir Isaac Newton. Since the publication of the immortal Principia, no scientific book has so widened the mental horizon of mankind as the Origin of Species. Mr. Darwin, like Newton, was a very young man when his great discovery suggested itself to him. Like Newton, he waited many years before publishing it to the world. Like Newton, he lived to see it become part and parcel of the mental equipment of all men of science. The theological objection urged against the Newtonian theory by Leibnitz, that it substituted the action of natural causes for the immediate action of the Deity, was also urged against the Darwinian theory by Agassiz; and the same objection will doubtless continue to be urged against scientific explanations of natural phenomena so long as there are men who fail to comprehend the profoundly theistic and religious truth that the action of natural causes is in itself the immediate action of the Deity. It is interesting, however, to see that, as theologians are no longer frightened by the doctrine of gravitation, so they are already outgrowing their dread of the doctrine of natural selection. On the Sunday following Mr. Darwin's death, Canon

Liddon, at St. Paul's Cathedral, and Canons Barry and Prothero, at Westminster Abbey, agreed in referring to the Darwinian theory as "not necessarily hostile to the fundamental truths of religion." The effect of Mr. Darwin's work has been, however, to remodel the theological conceptions of the origin and destiny of man which were current in former times. In this respect it has wrought a revolution as great as that which Copernicus inaugurated and Newton completed, and of very much the same kind. Again has man been rudely unseated from his imaginary throne in the center of the universe, but only that he may learn to see in the universe and in human life a richer and deeper meaning than he had before suspected. Truly, he who unfolds to us the way in which God works through the world of phenomena may well be called the best of religious teachers. In the study of the organic world, no less than in the study of the starry heavens, is it true that "day unto day uttereth speech, and night unto night showeth knowledge."—*June Atlantic.*

A CHEMICAL STOVE.

An alleged improvement by a Dresden chemist, Herr Nieski, in the new method of heating with acetate of soda, consists in mixing hyposulphate of soda with the acetate. The former melts more quickly than the latter, and retards crystallization in cooling. Herr Nieski uses one volume of acetate with ten of hyposulphate. The cases are filled to the extent of three-fourths, hermetically closed, and kept in hot water till one no longer hears a sound from crystals within on shaking. The cases will then give an equable heat from ten to fifteen hours according to size. A room-stove acting on this principle is described by Herr Nieski in the Deutsche Ind, Zeitung. It consists of an inner and outer cylinder, the latter having numerous small holes. In the space between the two stand three of the heating cases. These can be easily lifted out by the handles and put into water in the central cylinder, which can be heated in position by means of a burner below (or removed to be heated elsewhere). This done, the cases are lifted into their places in the circular space. The stove runs on castors and has a cover. The water in the inner cylinder furnishes, by evaporation, a wholesome degree of moisture.—*Boston Journal of Commerce.*

DEADENING SOUNDS.

A new plan to deaden floors has been patented, and is being tested in a new building at Philadelphia. A 6x3 plank is inserted between each joist two inches from the bottom of the joists, and projecting four inches beneath. Underneath the intervening planks the ceiling boards are nailed and the space filled with sawdust to within one inch of the joists. By this method the waves of sound are carried off, and it is claimed that the most vigorous hammering cannot be heard in the story beneath.

EDITORIAL NOTES.

WE have given considerable space in this number of the REVIEW to the article on "Tornadoes," by Sergeant John P. Finley, of the U. S. Signal Service, for two reasons: The paper is extremely opportune in view of the great number and violence of the tornadoes this year, nine tornadoes having already occurred. It is also a valuable contribution to science, and probably contains more scientific and practical information on this subject than can be found in any other similar publication. Under the direction of the Signal Service Bureau, Sergt. Finley has devoted five years to the special study of tornadoes. He has carefully gathered on the field the data of between six and seven hundred tornadoes, using pen and pencil in making up his note-books. Sometimes he has followed in the path of the tornado five and six hundred miles carefully placing on record the reports of all ocular observers, and has put himself in correspondence with thousands of observers of tornadoes in various portions of the country. This immense mass of material has been digested, and the substance has been compacted in this valuable paper.

IN the death of Henry W. Longfellow, America has lost a poet who takes very high rank in the republic of letters. His death marks the close of the first important epoch in American literature. The life of literature, like all other kinds of life, is one of pulsation; it has its ebbs and flows, its seasons of activity and inactivity. Chaucer and Gower were identified with the first forceful throb in English literature, after which came a barren epoch which was completely extinguished by the glory of the Elizabethan Age. Seldom does a nation experience more than one grand era in its history of literature. Such an epoch results from the crystallization of a nation's thought, and when the material is exhausted there must be time for the nation to gather new material, and receive new inspiration. When Bacon, Shakespeare and their contemporaries had passed from the scene the harvest had been gathered, and the nation's intellectual life was marked by feeble pulsations. Before the time of Bryant, Holmes, Whittier, Motley, Bancroft, Prescott and Irving, American literature can hardly be said to have demonstrated its own existence, or to have any real character. Of all writers of his age, and of all ages, Longfellow is distinguished for his purity of thought and beauty of diction. If poetry is the apprehension and expression of the æsthetical, Longfellow ranks among the best poets of this or of any past age. Longfellow was a man of the greatest personal worth, he was fairly womanly in the refinement of his sensibilities, his whole nature was as bright and joyous as a morning in May, and his inner being responded with youthful enthusiasm to everything beautiful or true in Art or Nature. His life was rounded out to the full period allotted to man on the earth, and the celebration all through New England and elsewhere of his seventieth birth-day was a golden fruition seldom accorded to the most favored ones of earth. We are painfully reminded that the golden era in American letters has closed, and we do not know how long it may be before the Nation may come to another fruitage.

BY the death of Charles Darwin natural science has lost its best observer. No work in science has been written about so much, or called forth so much criticism as the "Origin of Species." That work was written twenty-three years ago, and the effect of the new theory of evolution was prodigious. Many editions of the work in England and America have been published, and translations into all the chief foreign languages have been made. A catalogue was published

in Germany a few years ago giving the "Literature of Darwinism," which covered thirty-six pages, with the names of several hundred authors who have written on evolution. Charles Darwin was born in 1800, and was educated at Christ College, Cambridge. Soon after taking his degree he set out on a tour of the world in the ship "Beagle." The trip lasted five years during which he made vast collections in natural science, a part of which was published in 1839 in a three-volume narrative of the expedition. In the course of twenty years half a dozen other volumes were published whose foundations were laid during the voyage of the "Beagle." The result of these works has produced a marked modification of scientific belief, many of the best Christian scientists now believing in a species of theoristic evolution. It was a fitting token of honor that the great scientist should be buried in Westminister Abbey, by the side of royalty. Perhaps Mr. Darwin has given the best definition ever written of the theory of evolution in the following sentence: "Those who hold the theory of evolution conceive that there are grounds for believing that the present conformation and composition of the earth's crust, the distribution of land and water, and the infinitely diversified forms of animals and plants which constitute its present population, are merely the final terms in an immense series of changes which have been brought about, in the course of immeasurable time, by the operation of causes more or less similar to those which are at work at the present day."

WASHINGTON UNIVERSITY, at St. Louis, closed in June of this year one of its most successful years of work. In all departments of the University were enrolled about 1,400 students. This includes the Law School, the Undergraduate Department, the Manual Training School, the Smith Academy and Mary Institute for Girls and the Art School. At the annual meeting of the Board of Directors reports were received from the different departments. The Art School shows a large attendance and presents an urgent request for greater means. The Manual Training School is filled to its utmost capacity and during the present summer a large addition is being built. From the Director of the Observatory a report of the Extension Time Service of the Observatory was made and an urgent request for a few thousand dollars to to be spent in the way of fitting up the Observatory was presented. It was determined to raise three thousand dollars for this purpose. In view of the rapid growth of the various departments of the University, a resolution was passed that one million dollars additional endowment shall be raised within the next five years to place the University in proper shape for its work. It is confidently expected that this sum shall be raised within five years. On Friday evening, June 9th, occurred the exhibition of the Art School. The commencement of the Manual Training School and the Mary Institute occurred on Wednesday morning, June 14th, and the commencement of the Undergraduate Department and Law School was held in Memorial Hall on Thursday evening, June 15th. Besides a large law class three received the degree of B. A., three the degree of Engineer of Mines and one that of Civil Engineer. Upon Judge John R. Shipley was conferred the degree of LL. D., and upon Prof. C. M. Woodward, of Washington University, the degree of Ph. D., these being respectively the second and third honorary degrees ever conferred by the University.

THE Kansas Editorial Convention met in Lawrence, June 5th, and was largely attended. The sessions were held in Liberty Hall. Mayor J. D. Bowersock and Judge S. O. Thacher gave welcoming addresses to which Capt. Henry King returned the thanks of the Convention in his usually felicitous manner. The address of O. H. Rothacker, of Denver, (in his absence) was read by W. H. Rossington, of Topeka. After the meeting at Lawrence adjourned, the members visited the State Institutions. The convention was very enjoyable, the programme being carried out for the excursion under the excellent management of Col. S. S. Prouty, to the complete satisfaction of the whole party.

PROF. WILLIAM B. ROGERS, of the Institute of Technology, at Boston, died very suddenly, May 30th, while delivering a lecture at the Institute. His funeral drew a large number of scientists and scholars, and was largely attended by citizens. Professor Rogers was President of the National Academy of Science which is an office for life, the previous occupants having been Profs. Bache and Henry. In the death of Professor Rogers science has suffered a great loss.

WASHBURN COLLEGE, at Topeka, held its annual commencement beginning with the Baccalaureate Sermon, delivered by President McVicar, Sunday evening, June 11th. The Annual Address was delivered by James G. Dougherty, Monday evening, June 12th, the subject being "Orthodoxy." On Wednesday the commencement exercises proper, were held in the Congregational Church with a large audience. The college year has been one of unusual prosperity, and the College is growing and doing a good work.

THE Western Academy of Homeopathy held a convention in Kansas City, beginning June 20th, and lasting two days. There was a good attendance of members, and much interest manifested. A number of valuable papers were read and the subjects discussed. The next meeting will be held in St. Louis.

THE National Academy of Sciences was an outgrowth of the American Association for Advancement of Science. It is composed of the magnates of science in this country, and takes rank with the leading scientific associations in Europe. The Presidency is a life office and has had but three occupants, Profs. Bache, Henry and Rogers. The Academy consists of ninety-five members and four honorary members—ninety-nine in all. Thirty-four live in New England, seventeen in Massachusetts alone, and nine in the west—one in Ohio, one in Kentucky, one in Illinois, two in Missouri and four in California. Forty-three represent the mathematical sciences, as pure mathematics, astronomy, geodesy, engineering, physics, etc. Twelve represent chemistry; sixteen represent the geological sciences; twenty-four represent biological sciences and four are unclassified. Prof. James C. Watson, the astronomer, left about $50,000, the bulk of his property, to this Academy.

THE Kansas University held its commencement exercises June 6th. The attendance was unusually large, many being present from various portions of the State as well as a delegation of Kansas editors who were attending the Editorial Convention. Nothing transpired to mar the exercises which passed off pleasantly, the graduates doing themselves credit. The University is receiving a vigorous and substantial growth.

WE have received a hatchet from Mr. Teubner which has been forwarded to Prof. Putnam, of Salem, Mass. We shall be glad to hear from Prof. Putnam in regard to it, in due time.

THE storm of June 16th was remarkable for its violence, its brevity and the wide area over which it extended. Its intensity was greatest at certain points in eastern Kansas and western Missouri. At Kansas City one man lost his life by the falling of a building, and property was destroyed estimated at over $150,000. At Leavenworth four girls were killed at St. Mary's Academy, and the city received considerable damage. The storm occurred between twelve and one o'clock at night. It was not a tornado, but a hurricane. The wind at Kansas City was estimated at between sixty and seventy miles an hour, at Leavenworth it reached at its maximum over seventy miles an hour.

Washington University,

St. Louis, Mo.,

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II. MANUAL TRAINING SCHOOL: C. M. WOODWARD, Director. This is a School for Boys not less than Fourteen Years Old. The Course of Instruction runs through Three Years. Branches Taught are Mathematics, History, Physics, English Language and Literature, Drawing and the Use of Tools; the last named includes Carpentry, Pattern-Making, Blacksmithing, Machine Work, and the management of the Engine. Enrollment, 102 pupils.

III. MARY INSTITUTE: C. S. PENNELL, Principal. A Completely Equipped School for Girls and Young Ladies. Enrollment, 420 pupils.

IV. THE COLLEGE: M. S. SNOW, Dean. DEGREES—1. Bachelor of Arts. 2. Bachelor of Philosophy. 3. Master of Arts. 4. Doctor of Philosophy.

V. POLYTECHNIC SCHOOL: C. M. WOODWARD, Dean. DEGREES. —1. Civil Engineer. 2. Mechanical Engineer. 3. Chemist. 4. Engineer of Mines. 5. Architect. 6. Master of Science. 7. Doctor of Philosophy.

VI. ST. LOUIS SCHOOL OF FINE ARTS: HALSEY C. IVES, Director.

VII. ST. LOUIS LAW SCHOOL: W. G. HAMMOND, LL. D., Dean.

Standards of attainment are high in all departments, and promotions are made only on merit. Every department is in a high state of efficiency, and the best of discipline is maintained.

In the Undergraduate Departments, comprising the College and Polytechnic School, all facilities for the best education, Library, Apparatus, Laboratories, Assay Rooms, Gymnasium, Etc., are adequately supplied. All undergradutes have free admission to work-shop instruction in the Manual Training School.

In all the Secondary Schools the classes are generally full and applications should be made early.

Good board, with lodging, including fire and light, can be obtained at convenient places in the neighborhood for $20 per month and upward.

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